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Railway Mechanical Engineer

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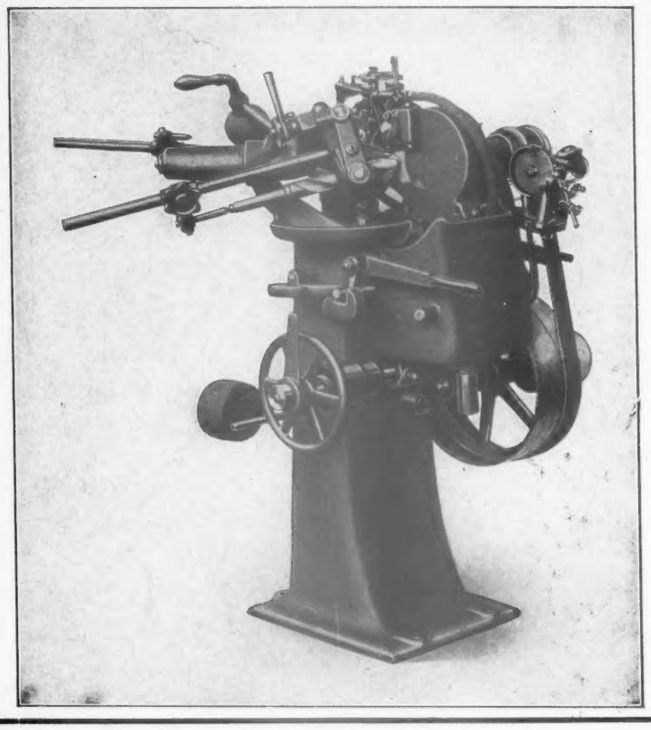

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Railway Mechanical Engineer

(Formerly the RAILWAY AGE GAZETTE, MECHANICAL EDITION *with which the* AMERICAN ENGINEER *was incorporated)*

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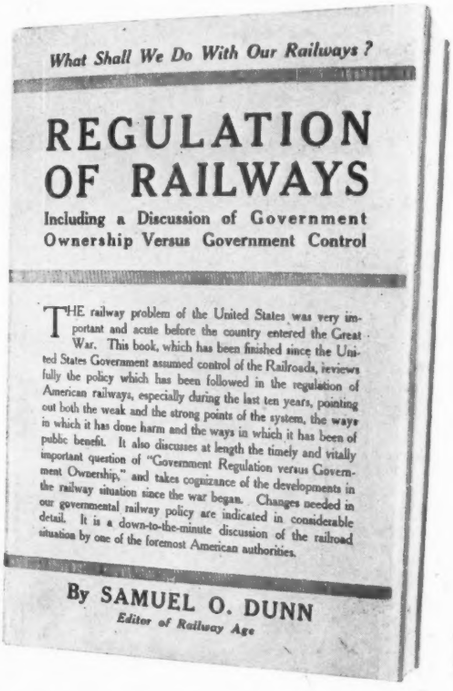
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Railway Mechanical Engineer

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Air Brake Conditions Demand Attention

The majority of men in the mechanical department apparently do not realize the condition of air brakes on freight cars. The general air brake inspector of a road that is noted for its good maintenance said recently: "If the present conditions prevail for another year it will be impossible to handle trains without the use of hand brakes. I know of a case where out of 48 cars the air brakes on 22 cars would not apply with an emergency application." Surely, such statements coming from a man who knows the actual conditions, furnish sufficient proof that the maintenance of air brakes demands immediate attention.

During the summer the air brakes give less trouble than during cold weather. Examine the cars in a train ready to start from the yard and you are certain to find reservoirs loose on the brackets, causing leaks in the piping, porous hose, brakes cut out and brakes that leak off, due to faulty packing leathers or other causes. The car inspector may be able to get the train out and the engineer may be able to operate it properly under favorable conditions, but when frozen hose causes leaks at the couplings and the air compressor and the locomotive are both overburdened such defects lead to costly delays on the road, and in extreme cases may cause wrecks.

The only way to get the brakes in condition for next winter is to start a vigorous campaign at once. Every car that comes into the shop should have its brakes put in thoroughly operative condition before it is allowed to go into service. The men in charge should see that the employees who do the air brake work on repair tracks are competent to handle it properly. At some of the principal yards dead lines should be established and no cars should be allowed to pass those points unless the air brakes are in operative condition. Trainmen should be taught to make use of M. C. B. standard air brake defect card, which is of great assistance to car men when making repairs.

To keep the air brake in good condition requires a considerable expenditure for maintenance. This expense is necessary for safe operation and no mechanical officer should hesitate to employ a force large enough to keep the brakes up to a high standard of efficiency. If the provision of the safety appliance act requiring that all freight trains should have air brakes on 85 per cent of the cars in operative condition had been strictly enforced last winter, many terminals would have been tied up. The roads must either do a great deal of air brake work during this summer or they must prepare to resort to the use of the hand brake next winter.

An Impetus to Safety First

"Safety First" has been so widely advertised by the railroads that it has become a common and almost hackneyed expression. The remarkable work that has been done on many roads has been widely heralded and commended. The general principles upon which the best managed safety first campaigns have been based have proved so efficacious that they have been applied with good results to campaigns for improved practices in other directions. That many railroads, or possibly the average railroad, have not fully awakened to their responsibilities (or privileges) in the safety first movement is indicated by the fact that the Railroad Administration, after investigation, has found it necessary to recommend for general adoption those methods which have been found most successful by the roads which are leaders in the safety first movement. To make the move-

ment a real success it will be necessary not only to install the right form or organization, but to put the real spirit into it and everlastingly keep at it. On those roads where the movement has been the greatest success the personality of some one man—or possibly several—has been behind the movement and has not only unceasingly hammered it home, but in such a way as to keep the interest of the employees at a high point all the time. It is important, therefore, that the right kind of a man be selected to head up the movement on each road, and at each point on each road. This is really of far greater importance than the form of organization, important as is the latter.

Spraying Method of Painting

The problem of proper protection of equipment by painting has become a very important one. With the demand for equipment as great as it is at the present time, the painting department is at a disadvantage in that it cannot get the equipment into the shop when it wants it and when once there it must be hurried through in order to get it back into active service. Every means, therefore, must be taken to speed up the work and at the same time have it properly done. The spraying system of painting has been used on several roads. By this method the equipment can be given ample protection, the work done in a much shorter time and many places inaccessible for brush painting can be reached. The chief criticism made of this system is that more paint is required to do a given piece of work than if it were painted by hand. This perhaps is true in cases where it is impossible to regulate the width of the spray as is the case in most home-made spraying outfits. But with an adjustable tip to the nozzle this objection can be overcome to a large extent, except where small surfaces are to be painted.

Even with these objections the saving in labor and the speed with which the work is done will offset the extravagance in the use of the paint materials. Where this method of painting is used indoors or in confined places, some means must be provided to clear the atmosphere of the paint fumes for the protection of the health of the operators. Where it is used in the open, however, it will be found that such precautions are not necessary.

Changing Freight Car Wheels

Last winter was productive of many unusual conditions in the operation and maintenance of equipment. One of these, which was exceedingly troublesome and serious in its consequences, was an epidemic of truck failures on freight cars. No doubt there are several causes to which this may in part be attributed, but it seems probable that the underlying cause was a lowering of the standard of wheel maintenance.

Under the stress of a shortage of car repairers and difficult working conditions, such as existed last winter, a tendency to overlook certain repairs may be expected. A high standard of maintenance is so essential in few other details, however, as in the changing of wheels. Defective wheels are not only dangerous in themselves, but may be productive of much damage to the whole truck structure, resulting in failures which may have disastrous consequences in the loss of life and property.

During the past year, the average weight of all car load freight and the amount of freight moving in full capacity car loads have both increased. Furthermore, in many cases there has been a reduction in the standard of track maintenance brought about by war conditions. It is clear, therefore, that a high standard of wheel maintenance is more essential than ever before. Whenever cars reach the repair track the wheels should be replaced even a little before the M. C. B. limits have been exceeded rather than allowed to remain in service with the probability of exceeding the limits before another opportunity for replacement has presented itslf.

Apprentice Training During the War

The loss of skilled mechanics since this country entered the war has created a serious situation in the railroad shops. On practically every road it is found that the average production of the workers has fallen off very markedly, due in a great measure to the large labor turnover. Probably no individual roads have suffered more through the loss of men from the shops than the roads that have maintained apprentice courses. Many of their best mechanics were comparatively young men who left the service to join the colors. The training of apprentices in railroad shops seems to have suffered a setback due to these unfortunate circumstances. It is discouraging to see the men who have received the apprentice training leave the service in such large numbers. Apprentices cannot be trained to fill the gaps in the ranks and specialized training is necessary to develop skilled machine operators in the shortest possible time. The roads that had well organized apprentice schools, however, found that they possessed an organization admirably suited for instructing new men, and these roads are to be commended for training the men they needed instead of merely luring them away from other shops.

Before the war apprentice training courses proved their value in developing the all-round mechanics necessary to maintain a flexible organization; during the war they have enabled the roads to cope with the serious labor situation. A consideration of the present conditions will convince anyone that an apprentice course will aid materially in meeting the situation that will arise after the war. There will be a great demand for mechanics who must replace what has been destroyed and make up for what has been left undone during the war. The railroads will have a tremendous task in bringing their neglected equipment up to the former high standards. Despite the difficulty of securing boys who will develop into mechanics, and in spite of the discouragement of seeing many of them leave soon after their training is finished, the roads should continue their apprentice courses in order to fill the depleted ranks of all-around railroad mechanics and to provide a class of men from whom the foremen of the future can be developed.

Conservation of Labor

The writer took occasion a few days ago to visit a manufacturing plant in the vicinity of New York City. A variety of work was being done, including the building of a highly developed special machine which required the most accurate workmanship and a variety of special jobs, most of them for use in war work and requiring great accuracy. The special jobs were in addition to the regular work for which the plant had been designed. The question that immediately came to mind was how it was possible to maintain a sufficient force of skilled mechanics to meet the demands for the increased output which was being required. Inquiry developed the fact that careful planning and adequate supervision had made it possible greatly to increase the output per worker in such a way that the workers were well satisfied. Many skilled men had left to join the colors, but this shortage had been largely overcome by using women workers for those classes of work for which they were best fitted. Not the least of the incentives to good work and greater output was a profit sharing plan. The plant manager, who was largely responsible for the improvement, was a railroad man, having served his time and received his early training as a machinist in a railroad shop.

Railroad shop managers are prone to argue that manufacturing and railroad repair shop conditions are so different that they are not comparable and that locomotive repair work, for instance, must be handled entirely differently from work in the average manufacturing establishment. It is true that there may not be as much routine work in a repair shop as in a manufacturing shop; it is true also that the size and weight of locomotive parts may require very different handling from the building of a machine tool; a higher degree of skill, however, is required to secure the greater accuracy which is necessary in the latter. The boiler shop and the erecting shop are hardly places for women workers, but there are many jobs in a railroad repair shop which can be performed quite acceptably by women workers, allowing the men to be transferred to the heavier work. In both the manufacturing shop and the railroad repair shop, however, the general principles governing the organization and the handling of the employees are much the same. Not a few railroad shop managers have failed to realize this and not only have they not examined and studied the best practices in industrial shops but they have not even availed themselves of the best practices in their own field. A point in question is shop scheduling in locomotive repair shops. Many, many times we have described such a system in these columns and have clearly and fully told of its advantages—and yet how slowly the practice has spread. Again, how many railroad shops are there which have really adequate apprenticeship systems; or how many railroads have done anything really worth while in making working conditions convenient and attractive for employees? Is it any wonder that factories of modern construction, headed by managers with a real vision of the labor problem, can attract men from many of our railroad shops?

Better Supervision of Equipment Repairs

There never was a time in railroad history when adequate supervision was so badly needed in the mechanical department as at present. The shortage of skilled labor which is already being felt, and which is likely to become more acute before a thorough stabilization of labor conditions is affected, is proving a serious handicap to the mechanical department in meeting the need for more and better repairs to equipment which the transportation industry feels so keenly today. While statistics may not show an acute shortage in the number of shop employees, the general readjustment of labor which has taken place during the past year has left the railroads with a much lowered standard of skill and efficiency of their shop employees. This has all the effect in decreased output and poor workmanship which would follow an actual reduction in the number of men employed under normal conditions.

That there can be much direct relief from this situation during the course of the war is extremely doubtful. The general exodus of skilled workers from the railroad ranks can and probably will be checked by wage readjustments, but in a large measure, the damage has already been done and, indeed, is only in keeping with the general labor stringency in all industries. The heavy overload which our transportation system must bear, however, permits of no lowering of maintenance standards or a decrease in output, and if the situation cannot be overcome directly, at least its effect must be neutralized. This can only be done through closer and better supervision. There must be no shortage of able foremen.

There has long been considerable difficulty in selecting and keeping a sufficient number of shop and roundhouse foremen, because the salaries paid these men have not been sufficient to attract the brighter and more capable men from the ranks. This situation has gradually been growing more acute during the past few years. Data compiled by the Railroad Wage Commission indicate that the average monthly compensation of the general foreman in the mechanical department has increased from $127.77 in 1915 to $137.73 in 1916. The average earnings per month of gang and other foremen were $97.24 in 1915, and $112.76 in 1917. Machinists earned on an average of $85.87 in 1915 and their average monthly earnings increased to $116.35 in 1917. The average monthly earnings of boilermakers increased from $89.68 in 1915 to $118.85 in 1917, and these figures tell only part of the story, as the brighter and more skilled men, working overtime or on a piece-work basis, actually earned much more than these averages. Why should a capable mechanic accept a position as foreman when he must do so at an actual loss of income, which, even with better than the average success in winning promotion, it will require years to overcome? Why should he give up comfortable working conditions to assume the heavy load of responsibility and the steady grind of long hours with almost no time that he can call his own?

Under the sliding scale of percentage increases recommended by the Railroad Wage Commission and put into effect by general Order No. 27 of the Director General of Railroads, these conditions are only aggravated, because while the average wage of the mechanic is greater than that of the lower grades of foremen, these earnings are made up of a standard wage at a base rate, to which is added pay for overtime, often at the rate of time and one-half time, or a substantial increase for piece work, while the earnings of the foremen are fixed absolutely by the base rate. Under these conditions, the increase which the foreman receives under Order No. 27, is not only a smaller percentage, but actually smaller in amount than that received by the mechanic. It would be hard to justify this situation on any grounds, and under the stress of present conditions it is intolerable.

Much has been said as to the needs of labor and too much care cannot be taken to insure that the great army of railroad workers receives full justice in any question of wages or conditions of employment that may arise. The fact must not be overlooked, however, that the effectiveness of any army depends largely upon the quality of its leadership, and there has never been a time when a higher quality of leadership was demanded in the motive power department than now. The situation, therefore, demands that there be an entire readjustment of the relation of the salaries of the lower supervising officers to the wages of mechanics in the motive power department.

Wheel Arrangement and Rail Stresses

The American Railway Engineering Association and the American Society of Civil Engineers have recently done some work that is of great value to locomotive designers. The report of the committee on stresses in railroad track presented at the A. R. E. A. convention in March contains data that will make it possible to design locomotives on a more scientific basis, to take advantage of the maximum capacity of the track without producing undue stresses in the rail.

It has long been recognized that the spacing of the wheels of locomotives and cars influences the stresses developed in the rails, but there has been little information available as to the exact nature of this effect. A theoretical analysis of the stresses in the rail under a single wheel load made by the committee showed that a positive bending moment would be developed at the point directly under the wheels, while negative moments would occur a short distance on each side. To find the effect of a combination of wheel loads, the bending moment curves for each wheel were superimposed. In the reports the case of a typical Mikado locomotive was considered. The drivers were 66 in. apart, and each bore a

load of 27,500 lb. The leading wheel was 104 in. from the front driver and carried 12,500 lb. and the trailing wheel was 120 in. from the rear driver and its load was 20,000 lb. While the depression of the track is of course greatest under the center drivers, the maximum bending moment occurs under the end driving wheels. If the bending moment due to a single isolated load is taken as unity, the ratio of the combined bending moments to the bending moment of the single load is as follows:

Under the leading truck wheel	.74
Under the first driving wheel	.69
Under the second driving wheel	.55
Under the third driving wheel	.53
Under the fourth driving wheel	.71
Under the trailing truck wheel	.85

These deductions have been verified by experiments conducted on typical sections of track with the locomotive whose weights and dimensions are given above. In these tests strain gages and stremmatographs were used to determine the intensity of stresses at a point below the edge of the rail when under load. The stress under the inner two drivers was in most cases found to be less than under the outer drivers and that under the front driver was somewhat greater than that under the rear driver. One of the facts brought out that deserves special notice is that although the load on the trailer was only about three-fourths as much as on each driver, the stress under the trailer was nearly as great as under the outer drivers.

Moving load tests were also made with the locomotive running at several speeds in order to determine the effect of impact and the dynamic augment due to the counterbalance for the reciprocating parts. In these trials steam was shut off before the test section was reached and readings were taken with the locomotive drifting. The position of the drivers was such that the counterweight of the first driver was at its lowest point when the wheel passed over one of the recording instruments, but the other drivers had the counterweights in different positions. It might be expected that due to the dynamic augment the stresses under the drivers would increase as the square of the speed, however it was found that the increases in rail stresses under all wheels were directly proportional to the speed. The rate of increase ranged from 0.3 per cent to 1.2 per cent for each mile per hour increase in speed. The increase under the first driver was not greater than for the other wheels. The rate of increase of stresses under the tender truck wheels was higher than that under the drivers, which would seem to indicate that impact is of more importance than the dynamic augment due to the counterbalance. The stresses due to the weight of the trailer wheels were greater than those due to the driving wheel loads for all the weights of rail tested, which ranged from 85 lb. to 125 lb. per yard.

During one of the static tests the third driver of the locomotive, was temporarily blocked up as is sometimes done in service to prevent a bearing from heating. The stress under this wheel, which was ordinarily about 14,000 lb., decreased to 2,500 lb. Under the back driver the stresses increased from 15,000 lb. to 26,000 lb. and there were also considerable increases in the stresses under the second driver and smaller increases under the remaining wheels.

Tests with Atlantic and Pacific type locomotives gave results corresponding to those for the Mikado type noted above. Even for speeds up to 60 miles an hour the increase in the stresses was proportional to the speed. The stresses under the trailer wheels of these locomotives were not as high as with the Mikado type, since the trailer was spaced closer to the rear driver.

The most important point brought out by these tests is the high stresses due to the trailer wheel. Many have thought that very heavy loads could safely be placed on the trailer, but this would seem to be a dangerous practice. The effect of wheel spacing on the stresses in track is a matter which should be given consideration in the design of locomotives and cars. It is to be hoped that the committee will secure additional information on this subject, as it is very much needed.

NEW BOOKS

Comparative Tests of Six Sizes of Illinois Coal on a Mikado Locomotive. By Edward C. Schmidt, et al. Bulletin No. 101, Engineering Experiment Station, University of Illinois, 100 pages, 6 in. by 9 in., bound in paper. Published by the University of Illinois, Urbana, Ill. Price 50 cents.

This bulletin contains a complete report of the tests which were run on the locomotive testing plant of the University of Illinois with a Baltimore & Ohio Mikado type locomotive, by the Committee on Fuel Tests of the International Railway Fuel Association, the Engineering Experiment Station of the University and the United States Bureau of Mines. An account of the same tests was presented by the Committee on Fuel Tests at the 1917 convention of the International Railway Fuel Association, an abstract of which report appeared on page 80 of the February, 1918, issue of the *Railway Mechanical Engineer.*

American Railway Tool Foremen's Association 1917 Year Book. Compiled by R. D. Fletcher, secretary and treasurer. 206 pages, 6 in. by 9 in., illustrated, bound in cloth. Published by the association.

On account of war conditions the 1917 convention was postponed so that the members of the association might not be called away from their work, but the annual year book was published as usual. In his letter of greeting, C. A. Shaffer, the president, expressed the hope that the preparation and publication of the year book would help maintain interest in the association so that its good work might be resumed when it is again possible to hold a convention. There are 18 papers in the book, prepared for the most part by members of the association and they are illustrated and well written. The subjects treated are divided into five classes: jigs and special devices, manufacture of small shop tools, special tools for boiler shops, heat treatment of tool steel, and the use of autogenous welding. A paper was written by E. Wanamaker, electrical engineer of the Rock Island lines, under the title of War and Welding, and it gives a valuable and somewhat exhaustive treatment of the subject.

Finding and Stopping Waste in Modern Boiler Rooms. Vol. II. By engineers of the Harrison Safety Boiler Works, Philadelphia, Pa. 274 pages, 4½ in. by 7 in., illustrated, cloth bound. Price $1.

This book is designated as publication No. 821 and is a reference manual to aid the owners and operators of boiler rooms in securing and maintaining plant economy. The book is divided into five sections, the first of which, in a discussion of fuel, refers to the sizes of coal, coal sampling, analysis, heating value, purchase of coal under specifications, and storage and weathering problems. The second section on combustion takes up the chemistry of combustion and considers in detail the requirements for the efficient burning of coal. The third and fourth sections treat, respectively, of heat absorption and boiler efficiency, the latter section covering heat balance, heat absorbed by the boiler, heat losses due to moisture in the coal, hydrogen, chimney gases, CO, combustible in the ash, moisture in the air, and unaccounted for losses. The fifth section, on boiler plant proportioning and management, discusses various arrangements of auxiliaries with regard to their effect upon feedwater heating, and also describes the Polakov functional system of boiler room management. All statements, tables and charts have been selected with special reference to their reliability and this book will be found of material assistance to power house engineers.

RECLAMATION ON THE SOUTHERN PACIFIC

A Description of the Extensive Salvage Work Done in the Largest Railroad Shop on the Pacific Coast

BY FRANK A. STANLEY

I

THE Sacramento, California, shops of the Southern Pacific constitute one of the most important railroad plants in America, holding first place in point of size among Pacific Coast shops, and, in fact, exceeding in extent the great majority of railway repair plants throughout the country as a whole. In variety of operations conducted within their numerous departments, they are excelled by few if any similar establishments anywhere. For, in addition to the usual sections constituting the average big rolling stock repair plant, this group of shops includes such important units as a large foundry for gray iron and chilled iron castings, a brass foundry for composition and brass castings, a wheel foundry for chilled-iron car and truck wheels and a rolling mill for producing merchant bar and a diversity of sections and shapes which are fabricated in the various shop departments. Then, too, the company operates here important car building shops; and in the machine shops, besides the regular work of overhauling and repairing rolling stock, a number of new locomotives are now turned out annually.

A further undertaking of interest in connection with repair operations, in that it is peculiar to this particular railroad plant, is the overhauling and upkeep of the mechanical equipment of numerous river steamers, ferry boats, dredging apparatus and other marine units operated by the company.

CONCENTRATION OF RECLAMATION WORK

As this is the biggest plant of the Southern Pacific, the most important of all the groups of shops located along its different lines, it is perhaps only logical that here should be centered one of the greatest of the system's industrial endeavors, the work of reclaiming old and discarded material from all of its divisions. And in this labor of reclamation, now an all powerful factor in every line of effort, lies one of the principle features of interest to the visitor at Sacramento.

Familiar as one may be in a general way with the handling of scrap material it is always interesting to learn what becomes of the enormous quantities of such material accumulated at different periods, and in what form it is destined to appear again in service. So far as concerns cast iron and brass scrap, there is, of course, small degree of complexity connected with its disposition. But wrought iron and steel parts that have found their way to the scrap heap form another problem altogether, and the disposal of such materials in extensive quantities is of particular interest.

In no line of activity is there greater accumulation of scrap of this character than in the operation of rolling stock. With, roughly, 70,000 locomotives and 2,500,000 cars in service over the 260,000 miles of track in our railway systems, there must necessarily develop a quantity of worn out and discarded material that constitutes in the aggregate, a vast volume of material when expressed in gross weight or in numbers of pieces.

The methods of the Southern Pacific at Sacramento hold much of value and interest to the student of reclamation work, not only because of the volume of business there daily transacted, but also on account of the diversified shop channels through which the scrap metal of the system is conducted in the various processes under which it is rehabilitated for service. With this fact in mind the following illustrations are here presented, along with certain data that may aid toward an understanding of some of the striking features of this important activity at the shops referred to.

A general view of the Sacramento scrap docks is reproduced at the head of this article. This photograph shows only a portion of the total area devoted to the dumping of the material switched in on the various spur tracks. While covering a fairly representative variety of scrap, the photo-

graph naturally falls short of conveying an adequate impression of the mass of material of all kinds that is constantly shipped in to this point, and which, as rapidly as it can be sorted, is hauled around to the rolling mill furnaces,

Fig. 1—Sorting Nuts for the Store House

the foundry, the forge shop, or to the special reclamation shops situated along the docks.

A closer view of one of the scrap piles is given in Fig. 2, showing the sorting of mixed scrap into big steel buckets, each of which is designated for a certain kind of part. These buckets when filled are picked up by the locomotive crane and transferred to flat cars for hauling to some specified shop department. It will be noticed that the work of sorting and many of the reclamation operations in the scrap dock shops are performed very largely by women.

In the sorting out of the scrap some 60 to 100 tons daily is prepared for the rolling mill furnaces, the capacity of the mill being easily the latter figure. The scrap for the mill is sorted into various classes, cut up into definite lengths, piled into units of 200 or 350 lb., placed on cradles on flat cars and thus transferred to the heating furnaces. In the making up of the piles at the dock sheds, plates, bars, levers, bolts, pins, etc., are cut by power shears and the oxy-acetylene torch. The plate sections are used for bottom and sides of a box like frame into which bolts, rod sections, and other pieces are piled and the whole pile then secured by flat iron straps clamped around it by an air operated press.

Fig. 3—Old Air Brake Hose Storage

Details of the preparation of these piles and the methods by which they are later passed through mill rolls, hammer, bulldozer, headers and other machinery in the manufacture of new parts will be taken up at another point in this article.

Fig. 2—Women Sorting Scrap at the Sacramento Shops of the Southern Pacific

In the sorting of scrap, all parts that can be reclaimed in their original form without being worked into raw material for starting anew through the shop processes, are laid aside and classified for attention in the reclamation shops at the scrap docks. This means that great quantities of

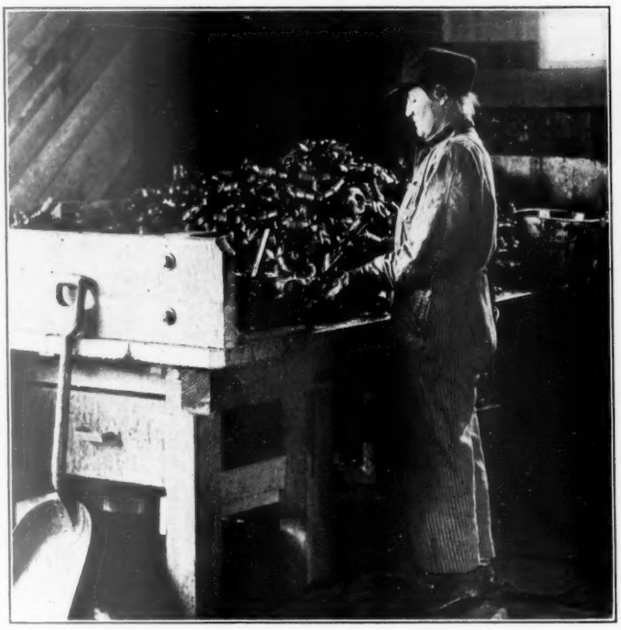

Fig. 4—Painting Air Hose Couplings

track bolts, spikes, tie plates, car bolts, nuts, washers, pins, and a multitude of other materials are accumulated from the regular run of scrap and put into condition for further use by simple operations on the apparatus immediately to hand.

Bolts that are worn on the threads and bent out of shape are straightened, cut off and threaded; nuts are retapped; spikes straightened and sharpened; washers straightened and sorted for all sizes of bolts; hose couplings removed, painted and refitted to new hose lengths; and so on the parts are reclaimed and placed in proper bins in the general stores.

SOME SPECIFIC OPERATIONS

Two views in the scrap dock shops, Figs. 1 and 5, illustrate respectively, the sorting of nuts, and the re-tapping of nuts and the stripping of old air hose. In the case of square nuts alone, as many as 75,000 of various sizes are retapped in a single month at this point. Expressed in units of weight, this would amount to over 12,000 lb. or over six tons of nuts reclaimed in the period indicated. The multiple spindle tapping machine for nut operations

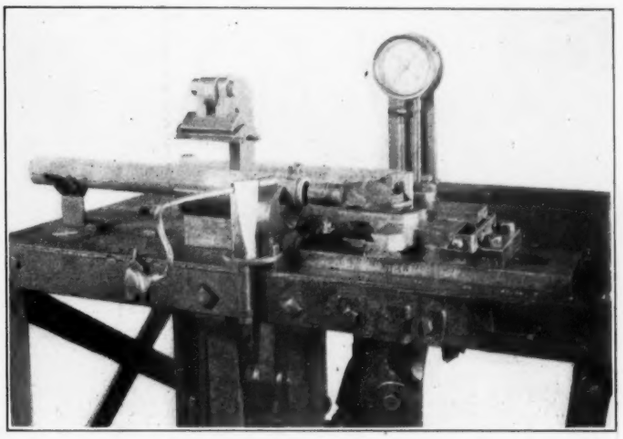

Fig. 6—Hose Coupler Mounting Machine

is seen at the left in Fig. 5, while to the right is the stripping bench for old air hose. Here the hose lengths are gripped in pneumatically operated jaws while the clamps and connections are rapidly removed.

The extent to which air hose is handled is indicated in Fig. 3, and a definite idea of the number of fittings reclaimed is found in the figures for a month's work, which show an average of 10,000 couplings and the same number of nipples for that period of time. An estimate on a conservative basis for a year's output in the reclamation of this material would run to at least 80,000 or possibly 100,000 air brake hose alone.

Fig. 4 shows something of the method followed in preparing the reclaimed hose couplings and nipples for remounting.

Fig. 5—Rethreading Nuts and Stripping Old Air Hose

The process of painting here represented consists in dipping and brushing the fittings with a preparation which is composed of black varnish mixed with distillate in proportions of 1 to 2 to thin it to the desired consistency. After drying

Fig. 7—Reclaiming Track Bolts

they are remounted in new hose with the apparatus shown in Fig. 6. This is another pneumatic machine with air pistons for controlling the action of the jaws and the movement of the carrier for the coupling.

The length of hose with the clamp on one end is slipped into the horizontal fixture on the bench and the coupling placed on the slide at the right. The top jaw at the time the picture was taken was elevated as shown and the instant air pressure is admitted to the bottom operating cylinder, the jaw grips the hose fast while the air operated slide at the right is forced forward pressing the coupling into the hose. This movement takes place rapidly and is followed instantly by the closing of the narrow jaws near the end of the hose upon the clamp, which is then tightened in place by applying the crank wrench at the front to the nut on the binder bolt. The wrench is carried in the right position by a swivel holder and accomplishes its work in a comparatively short time.

Fig. 9—Sorting Washers

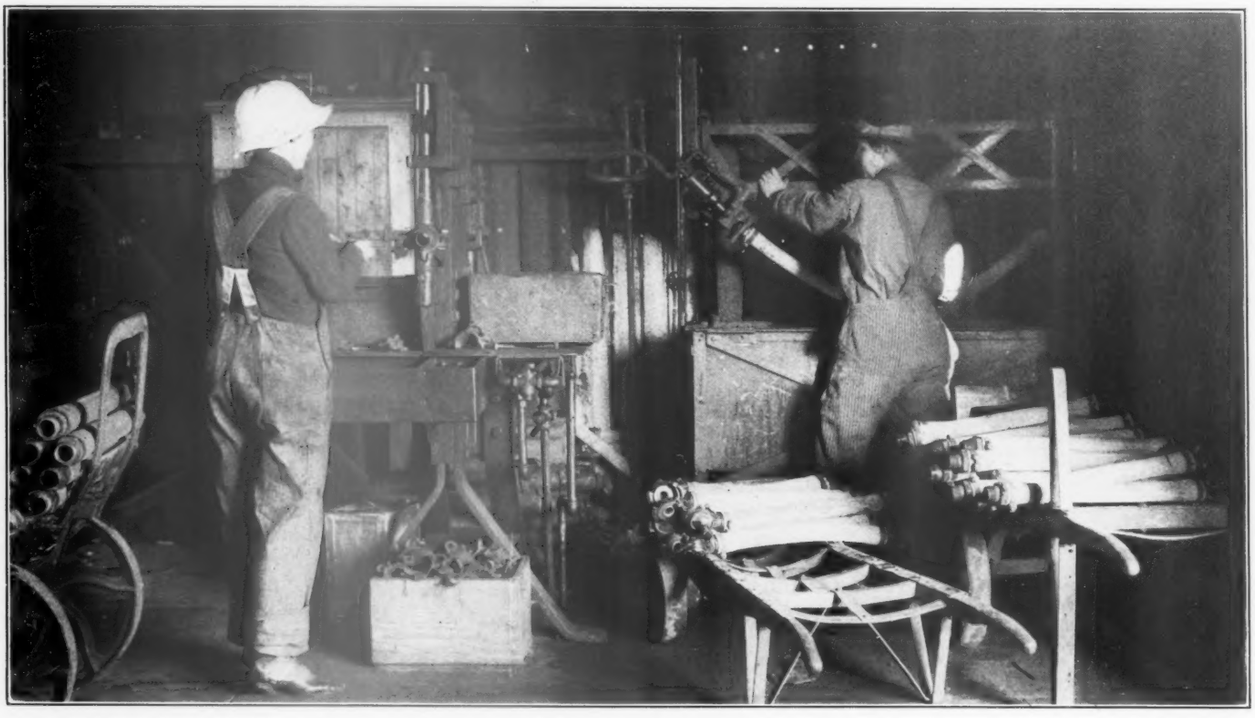

Fig. 8—A Corner of the Hose Testing Room

Another machine for applying clamps is seen to the left in Fig. 8, while to the right in the same view is the apparatus for testing the hose under pressure.

BOLTS, WASHERS AND OTHER PARTS

Fig. 7 shows the method of reclaiming of track bolts. Washers are sorted and grouped (Fig. 9), where different

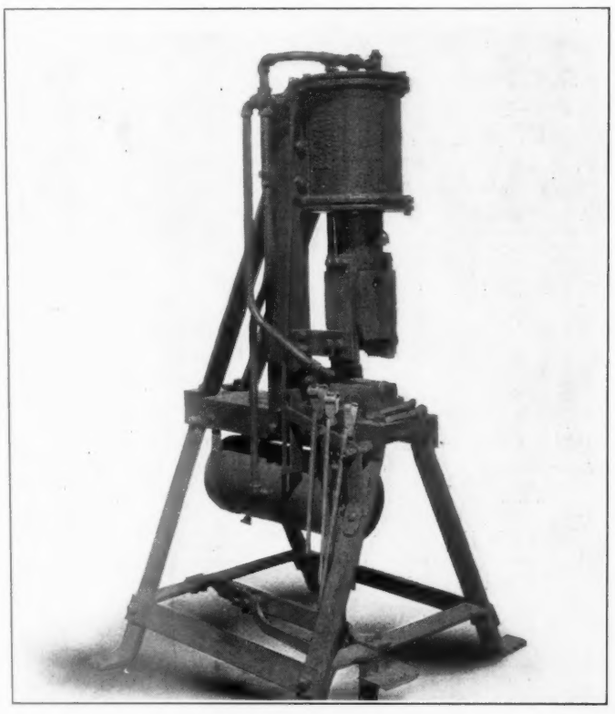

Fig. 10—Strengthening Hammer for Reclaiming Spikes

sizes are shown placed on individual pegs as fast as they are inspected, and are then transferred to the storage bins. Track spikes are reclaimed in great quantities, these being articles

Fig. 11—Sharpening Track Spikes

that once bent, seem never to appeal to the section hands until straightened and sharpened again. A special machine for the straightening operation is shown by Fig. 10. It is a home made affair with air piston carrying a hammer die while the lower die is secured to the table of the machine. The apparatus is controlled by the foot lever at the front. As fast as they are straightened, the spikes are taken to the grinding machine shown in Fig. 11, where they are resharpened and are then ready to be shipped out on the road again for future work.

Among the odd items connected with important reclamation operations is the removing of zinc and brass from exhausted battery cells, a process illustrated in Fig. 12. Even this apparently small item results in the saving of a very considerable amount of valuable material in the course of a little time.

Another feature included in this view is a pile of locomotive shoes and wedges from which the brass liners have been melted, this practice resulting in the saving from such sources of about 250 lb. of metal daily, or nearly three tons of brass per month.

MISCELLANEOUS ITEMS

There are many things in process of reclamation at Sacramento that are practically impossible to illustrate, but which may be referred to as of importance in connection with the activities herein discussed. For example: One department handles the repairs to such tools as monkey wrenches, Stilson wrenches and other appliances, gate

Fig. 12—Reclaiming Metal from Old Batteries

valves, globe valves, pipe unions and fittings of all kinds, these miscellaneous items extending into an important total for the month's work.

In this period an average of 400 or 500 gate and globe valves are overhauled and put into shape by reseating and regrinding operations carried out on special equipment, 100 or more wrenches of various types are repaired, and some 3,000 pipe unions of different sizes are reclaimed for service by tumbling in rattlers and dipping in wiping oil or distillate. Similarly in a small smith shop at the docks a blacksmith reclaims all sorts of bent and twisted material of fairly light weight.

Some indication of this is given in the statement for any average month's work which would include among other things the straightening and reforming of such items as: 1,000 coupling pins; 150 car carry irons; 54 air cylinder levers; 1,500 brake shoe keys; 70 coupling levers; 54 car angle irons; 125 steel bottom carry irons; 500 small corner irons; 260 large irons; 150 door hangers; 25 door fulcrums; 125 car levers; 2,000 oil box corners; 200 tie plates; 5,000 grab irons; and other miscellaneous small forgings of various kinds weighing 2,300 lb. Totalling up such items as the

above gives an aggregate weight of the reclaimed parts of over 70,000 lb., or some 35 tons, and this of course represents but a portion of the sum total of such material put into shape at the reclamation docks.

(*To be concluded.*)

DISTRIBUTION OF STANDARD LOCOMOTIVES TO THE RAILROADS

The United States Railroad Administration has placed orders for 390 locomotives in addition to the 1,025 ordered some time ago. The orders are divided about as follows: From the American Locomotive Company, 130 light Mikados, 100 6-wheel switching and 15 heavy Santa Fe. From the Baldwin Locomotive Works, 57 heavy Mikados, 13 light Pacific and 30 Consolidation for anthracite burning. From the Lima Locomotive Works, 45 light Mikados. This brings the total of orders placed with the three companies up to 800 to the American Locomotive Company, 570 to the Baldwin Locomotive Works, and 45 to the Lima Locomotive Corporation, a grand total of 1,415 locomotives. With the exception of the 30 Consolidation type locomotives for anthracite coal, the locomotives are all of the standard types.

An apportionment has been made of the locomotives and freight cars ordered by the Central Advisory Purchasing Committee, based on orders placed by the roads as revised by the regional directors and the administration at Washington. The cars and locomotives will not be treated as the property of the government or as a "circulating reserve," but become the property of the railroads in practically the same way as other equipment. The federal manager of each road has been notified of the number assigned to it and asked to submit a formal requisition to the Division of Capital Expenditures. The railroads will finance the equipment themselves wherever possible but if necessary they may apply to the government, through the Division of Finance and Purchases, for a loan from the revolving fund.

The assignment of the locomotives is as follows:

Distribution of Standard Locomotives

Railroads	Assignment	Total
Light Mikado		
Baltimore & Ohio	100	
Chicago & Alton	15	
Chicago & Eastern Illinois	15	
Chicago, Indianapolis & Louisville	5	
Chicago, Milwaukee & St. Paul	50	
Chicago, Rock Island & Pacific	20	
Grand Trunk, East	15	
Grand Trunk, West	25	
Lehigh & Hudson River	4	
Long Island	6	
Nashville, Chattanooga & St. Louis	10	
New York Central	95	
Big Four	25	
Lake Erie & Western	15	
Michigan Central	20	
Pittsburgh & Lake Erie	10	
Pittsburgh, McKeesport & Youghiogheny	10	
Rutland	6	
Toledo & Ohio Central	15	
Oregon Short Line	20	
Pittsburgh & West Virginia	3	
Seaboard Air Line	10	
Texas & Pacific	11	
Southern	25	
Union Pacific	20	
Wabash	20	
Western Pacific	5	575
Large Mikado		
Central of New Jersey	25	
Chicago Great Western	10	
Elgin, Joliet & Eastern	2	
Erie	50	
El Paso & Southwestern	5	
Louisville & Nashville	20	
Missouri, Kansas & Texas	25	
Wheeling & Lake Erie	20	157
Light Mountain		
New York, New Haven & Hartford	10	
Southern	25	35
Large Mountain		
Chesapeake & Ohio	5	5
Light Pacific		
Atlantic Coast Line	20	
Baltimore & Ohio	20	
Kansas City Southern	3	43
Heavy Pacific		
Erie	20	20
Light Santa Fe		
Ann Arbor	4	
Boston & Albany	10	
Baltimore & Ohio	26	
Chicago & Western Indiana	5	
Duluth, Missabe & Northern	10	
Pennsylvania Lines West	30	
Southern	50	
Seaboard Air Line	15	150
Heavy Santa Fe		
Bessemer & Lake Erie	5	
Chicago & Eastern Illinois	5	
Erie	25	
Colorado & Southern	5	
Nashville, Chattanooga & St. Louis	10	50
6-Wheel Switch		
Atlantic Coast Line	5	
Baltimore & Ohio	20	
Chicago Great Western	5	
Chicago Junction	14	
Chicago, Rock Island & Pacific	10	
Central Railroad of New Jersey	10	
Grand Trunk Western	5	
Mobile & Ohio	10	
Oregon Short Line	5	
Pittsburgh & West Virginia	2	
Pennsylvania Lines West	20	
Seaboard Air Line	10	
Texas & Pacific	14	
Terminal St. Louis	10	
Union Pacific	10	150
8-Wheel Switch		
Atlanta & West Point	2	
Erie	16	
Elgin, Joliet & Eastern	8	
Georgia	2	
Kansas City Terminal	5	
Long Island	4	
Missouri, Kansas & Texas	10	
New York Central	25	
Big Four	10	
Indiana Harbor Belt	20	
Kanawha & Michigan	3	
Lake Erie & Western	3	
Michigan Central	10	
Rutland	2	
Toledo & Ohio Central	5	
Southern	20	
Wheeling & Lake Erie	5	150
Light Mallet		
Chesapeake & Ohio	20	
Chicago & Western Indiana	10	30
Heavy Mallet		
Virginian	20	20
P. & R. Standard Consolidation		
Philadelphia & Reading	30	30
Total	...	1,415

The new locomotives will be required to work their way home, under steam and pulling a train of cars, according to a plan now under consideration by the Railroad Administration. The idea has been recommended by Frank McManamy, manager of the locomotive section of the Railroad Administration. It is estimated that this plan applied to 3,000 new locomotives a year would handle perhaps 500,000,000 ton-miles of freight a year, by enabling each engine to haul a train, instead of itself occupying tonnage in a train equal to about three cars. The idea is to have the engines accompanied by a messenger from the locomotive plant, according to the usual practice, to look after the bearings, etc., during the trip, and to have them handled by regular crews of the roads over which they pass. It is believed that they will be delivered in better condition if used at the front of a train and given a thorough inspection at terminals than if handled in the usual way and that they may be "broken in" just as satisfactorily in this way as if the process were postponed until their arrival at the home road.

W. S. S. NURSERY RHYME

"Gin a lassie meet a laddie, going to the Rhine,
Here's a lass would help ye, laddie, Saving Stamps I'm buyin'.
Every lassie has a laddie! And I think of mine,
But *all* the lads they smile at me when Savings Stamps I'm a buyin'."

—*Pioneer Bulletin.*

DRAFTING MODERN LOCOMOTIVES

A Study of the Steps Taken in Developing Maximum Draft Efficiency on N. & W. 4-8-2 Type Locomotive

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Engineer of Tests, Norfolk & Western, Roanoke, Va.

II*

IN compiling the data obtained from the Norfolk & Western 4-8-2 type drafting tests, they have been arranged to show a ready comparison of the standard nozzles with and without bridges, the influence of the length of the inside extension of the stack, the sizes of nozzles, both standard and annular, as well as the diameters of the stacks. The results as shown in the tables are the averages of one or more runs, as indicated by the run numbers in column No. 1.

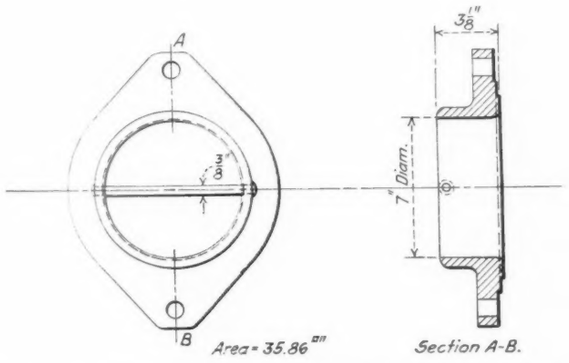


Fig. 4—The Seven-Inch Nozzle with a Bridge Originally Used on N. & W. Mountain Type Locomotives

In referring to the results of these tests, as presented in the tables, the items "Exhaust pressure," "Draft, front end" and "Draft efficiency" will receive the most consideration. Exhaust pressure as obtained from steam gage indication has been used in preference to least back pressure obtained from the indicator diagrams, as the exhaust pressure readings were more uniform and consistent than the least back pressure results as taken from the indicator cards. The exhaust pressure was indicated directly while least back pressure results could be affected by slight lost motion in indicator parts, the tracing of the diagrams, and possible error in scaling the least back pressure with a 120-lb.-per-sq.-in. scale.

COMPARISON OF STANDARD NOZZLE WITH AND WITHOUT BRIDGE

In Table I, group *A*, attention is directed to the performance of the locomotive while equipped with a 7-in. diameter standard nozzle operating with and without a bridge. The design of this standard nozzle is shown in Fig. 4. The 7-in. standard nozzle was tried in connection with an 18-in. diameter stack provided with 26½-in., 14¼-in. and 9-in. inside extensions. The results from run No. 17 are representative of the locomotive's performance with the standard front end arrangement; the larger exhaust stand used was the only deviation from the standard arrangement. In run No. 18 the same arrangement of front end was used except that the ⅜-in. bridge was removed from the standard nozzle. The removal of the bridge naturally increased the area of the nozzle, which had its effect both upon the reduction of exhaust pressure and reduction of the draft. Column No. 13, "Draft efficiency," has been recognized as a convenient means of comparing draft performances of locomotives, as in it are involved both the exhaust pressure and draft results. This item is obtained by dividing the draft, expressed in pounds per square inch, by the exhaust pressure.

With the 26½-in. inside extension of the stack, the draft efficiency is 3.6 per cent higher when the bridge is used with a standard nozzle. In the 14¼-in. inside extension, the draft efficiency is 6.7 per cent higher with the use of a bridge, while with the 9-in. inside extension it is observed that the draft efficiency is 10 per cent better with the bridge removed.

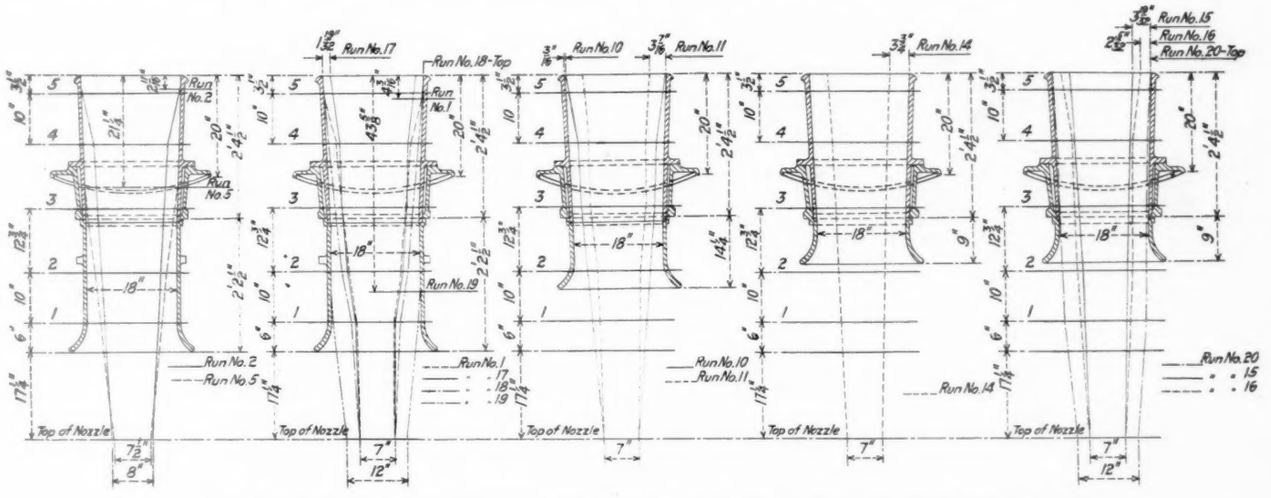


Fig. 5—Exhaust Stack Diagrams for Runs 1, 2, 5, 10, 11, 14, 15, 16, 17, 18, 19 and 20

* For first article see *Railway Mechanical Engineer* for June, 1918, page 331.

The fact that the exhaust did not fill the stack, either with or without the bridge with the 9-in. inside stack extension, is the possible reason why the removal of the bridge had an influence on the draft efficiency the reverse of what had already been observed.

In Fig. 5 the position of the exhaust columns with relation to the inside walls of the stack is shown for the tests included in group *A*. It has been observed in connection with these tests that shortening the inside extension had the same influence upon the relationship existing between the position of the exhaust column and the walls of the stack as did increasing the diameter of the stack. It is noticed in run No. 16, where no bridge was used, that the exhaust column more nearly filled the stack than in runs No. 14-15 where the bridge was employed. This feature of the exhaust in run No. 16 is no doubt responsible for the slightly increased draft efficiency which has been recognized, as it has been observed throughout this series of tests that the draft conditions are improved when the relation of the exhaust column and stack are such that the exhaust completely fills the stack before being discharged. The increase in draft efficiency secured with the 7-in. standard nozzle without the bridge, using a 9-in. inside stack extension, was obtained at the expense of a decided decrease in draft, which was counter to the object of the test, as the primary purpose was to improve the draft without creating an objectionably high exhaust pressure.

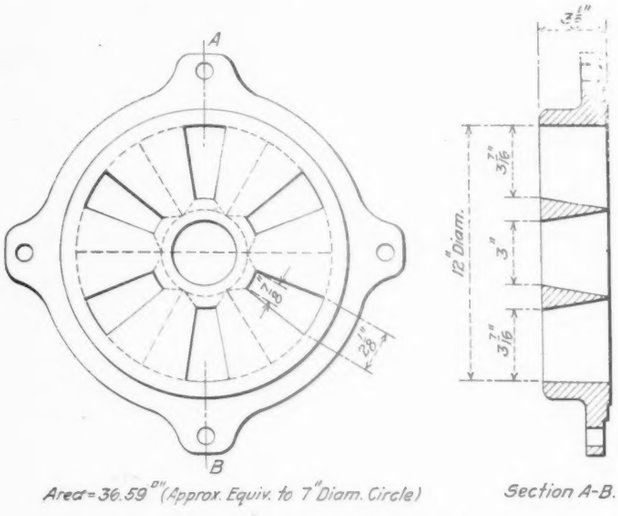


Fig. 6—Plain Annular Nozzle A-1

Table II gives further information in connection with the operating conditions of the test and some of the results obtained. Still directing attention to the results in group *A*, it is observed that the operating conditions were very uniform, as far as the number of cars and tonnage in the train were concerned. Under item No. 24 the amount of water used for each run is shown. This represents the steam consumed by the locomotive and accessories, such as air pumps and stoker engine. Special care was taken to see that no waste of steam occurred through the safety valves during the test. By observing the intensity of the draft in the locomotive front end between the baffle plate and the front tube sheet, and in the fire box, it was possible to determine the draft effort expended in drawing combustion gases and air through the different sections of the boiler. It will be observed that from 16.3 to 19.5 per cent of the draft effort was required to draw the gases under the diaphragm; from 61.5 to 66.6 per cent of the draft was expended in drawing the gases through the tubes, and from 14.8 to 20.5 per cent of the draft effort was required to draw the air through the fire bed.

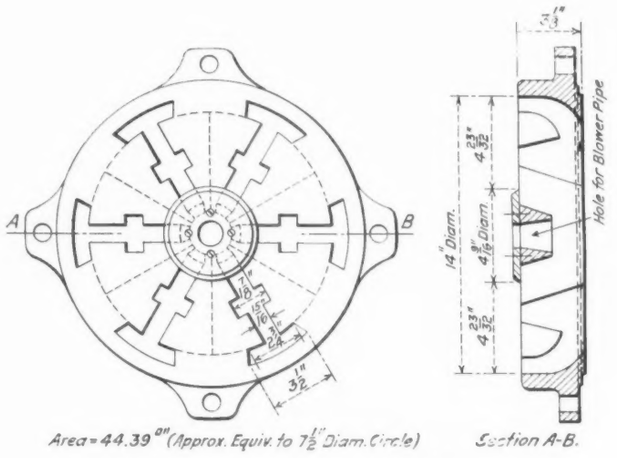


Fig. 8—Waffle Iron Nozzle A-2

The fuel used in these tests was fairly uniform in quality, ranging from 13,000 B.t.u. to 14,000 B.t.u. The analyses of the smoke box gases indicated that very good combustion results were being obtained. The values for CO_2, with but few exceptions, ranged from 10.2 per cent to 12.4 per cent.

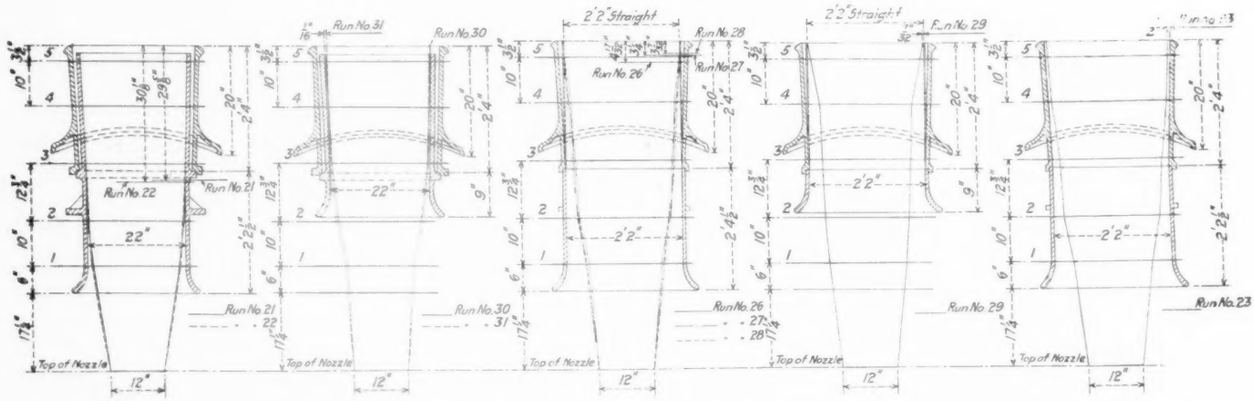


Fig. 7—Exhaust Stack Diagrams for Runs 21, 22, 23, 26, 27, 28, 29, 30 and 31

COMPARISON OF LONG AND SHORT INSIDE STACK EXTENSIONS

In Tables I and II, group *B* has been arranged particularly for a study of the influence of the length of the inside

stack extension. Included in this group of data are the results obtained from a special annular nozzle, style A-1, as illustrated in Fig. 6. This nozzle has six equally spaced annular ports of equal area and one center circular port. The combined areas of the ports were made to correspond to the areas of 7-in. and 7½-in. diameter circles.

The first comparison in group *B*, Table I, is that of the 7-in. diameter nozzle with a ⅜-in. bridge, used with an 18-in. diameter stack with 26½-in. and 9-in. inside extensions. The higher draft as well as the slightly higher draft efficiency was obtained with the 26½-in. inside extension. Under neither of these conditions was the exhaust filling the stack, but with the longer extension (run No. 17) it was more

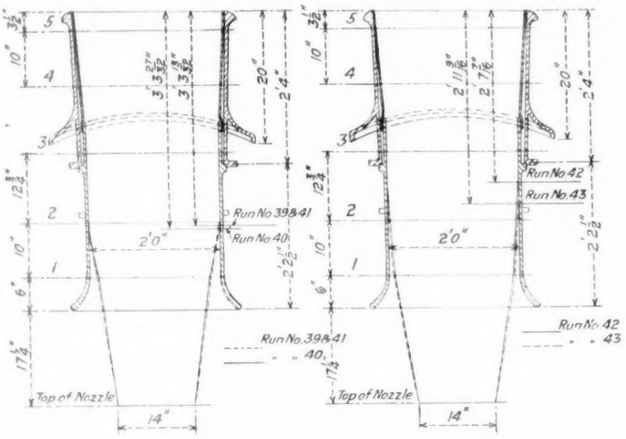


Fig. 9—Exhaust Stack Diagrams for Runs 39-41, 40, 42 and 43

closely approaching the walls of the stack than in runs No. 14-15 with the short extension, as indicated by the exhaust diagrams shown in Fig. 5. Runs No. 19 and 20 provide a comparison of nozzle style A-1 used with an 18-in. diameter stack with 26½-in. and 9-in. inside extensions. The better draft condition is again observed with the 26½-in. inside extension; the draft efficiency in this combination was 0.031 as against 0.028 with the 9-in. extension. The exhaust column and stack diagrams for runs No. 19 and 20 are also shown in Fig. 5. It will be noticed with the 26½-in. inside extension that the exhaust is striking near the bottom of the inside extension, or 43⅝ in. from the top, but with the 9-in. inside extension the exhaust, while almost in contact with the stack in its passage, does not absolutely strike until it reaches the top.

Attention should be directed to the marked contrast in the draft obtained from run No. 17 as compared with run No. 19, where the only difference in the front end arrangement was the different type of nozzle used, the former run representing the performance of the standard 7-in. diameter nozzle with ⅜-in. bridge where a draft of only 8.91 in. of water was registered, while the latter shows nozzle style A-1 with area equivalent to a 7-in. diameter circle, where a draft of 10.1 in. of water was registered. The draft efficiency was also increased from 0.029 in the former instance to 0.031 in the latter.

Runs No. 21-22 and 30-31 show the results obtained from nozzle style A-1 enlarged to correspond to the area of a 7½-in. diameter circle, operated in connection with a 22-in. diameter stack with 26½-in. and 9-in. inside extensions. In this comparison, the higher draft was obtained with the 26½-in. inside extension. It will further be noticed that the draft efficiency was 0.046 with the 26½-in. inside extension as compared with 0.040 with the 9-in. inside extension. The exhaust column stack diagrams for these runs are shown as Fig. 7. It will be observed that, with the 26½-in. inside extension, the exhaust was striking the stack 29⅞ in. from the top, while with the short inside extension the exhaust was missing the stack by ¼ in. at the location of the top Pitot tube, although, as indicated by the diagram, the exhaust was very closely paralleling the walls of the stack after 12 in. entry into the lower section.

The records from runs No. 26-27-28 contrasted with run No. 29, give the results obtained from using nozzle style A-1 with area equivalent to a 7½-in. circle, operated in conjunction with a 26-in. diameter straight stack with 26½-in. and 9-in. inside extensions. In this, as in former comparisons of the same nature, the better draft performance was obtained with the 26½-in. inside extension, where a draft efficiency of 0.048 was secured, as compared with 0.040 with the 9-in. inside extension. The exhaust stack diagrams are shown in Fig. 7, where it is observed that the exhaust column was clear of the stack until it closely approached the top. In runs No. 26-27-28 with the 26½-in. inside extension, the exhaust column encountered the walls of the stack 3⅝ in. from the top while in run No. 29 with the 9-in. inside extension, the exhaust missed the stack by ¼ in. at the top.

In Table II, group *B*, is given further information as to the operating conditions, together with some of the results obtained, particularly with reference to running time, as shown in column No. 15. The draft effort absorption required to draw the combustion gases and air through the different sections of the boiler, as shown in columns No. 18, 19 and 20, are values of peculiar interest.

Attention should be directed to the increase in the tonnage of the train after the first test was made with nozzle style A-1 with area equivalent to a 7½-in. diameter circle. With the same train tonnage as formerly used, it was necessary frequently to apply the brakes to restrict the speed. In succeeding runs with this same size nozzle, the tonnage was increased until, for runs No. 26 to 29, inclusive, the tonnage was 639.5 and 640.1, whereas the tonnage had been averaging slightly above 600 tons.

From a review of the data relating to the length of the

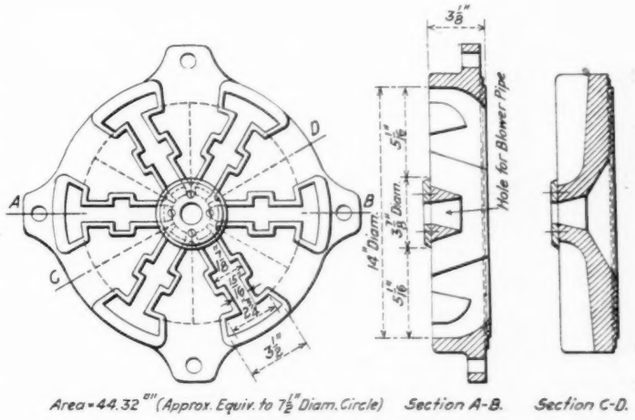


Fig. 10—Waffle Iron Nozzle A-3

inside extension, the conclusion is reached that the best results are obtained from the 26½-in. inside extension. It was also observed that the best draft conditions cannot be obtained unless the exhaust strikes the stack, and that the draft conditions are improved as the point of contact with the stack occurs about 38 in. from the top, which is equal to approximately 70 per cent of the length of the stack.

The introduction of the annular nozzle, style A-1, gave considerably better performance than the former standard nozzle, as it was found possible to operate this nozzle with an area equivalent to a 7½-in. diameter circle, and when used in conjunction with a 22-in. diameter stack and a 26½-in. inside extension, a draft of 10.39 in. of water was obtained, with a draft efficiency of 0.046, as compared with

TABLE I

Run No.	Stack: Diam., in.	Stack: Length inside extension, in.	Nozzle: Act'l or equiv. diam., in.	Nozzle: * Style and diam. bridge	Area	Speed, M. P. H.	Pressure, lb. per sq. in.: Boiler	Pressure, lb. per sq. in.: Exhaust	Draft, in. water: Front end	Draft, in. water: Back of baffle	Draft, in. water: Firebox	† Draft efficiency	‡ Exhaust jet striking, in. from top of stk.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
GROUP A—COMPARISON OF BRIDGE AND NO BRIDGE IN STD. NOZZLES (EXHAUST STAND 12 IN. IN DIAM.)													
17	18	26½	7	S ⅜	35.86	33.0	192.5	10.94	8.91	7.25	1.32	.029	— 1⅝
18	18	26½	7	S none	38.48	30.2	187.4	8.13	6.34	5.10	1.12	.028	Top
11	18	14¼	7	S ⅜	35.86	27.8	194.4	7.83	7.00	5.86	1.40	.032	— 3 7/16
10	18	14¼	7	S none	38.48	29.4	192.8	7.68	6.51	5.34	1.34	.030	— 3/16
14–15	18	9	7	S ⅜	35.86	31.3	194.4	9.81	7.60	6.28	1.28	.028	— 3 11/16
16	18	9	7	S none	38.48	30.5	193.6	7.63	6.58	5.40	1.10	.031	— 2⅛
GROUP B—COMPARISON OF LENGTH OF INSIDE STACK EXTENSIONS (EXHAUST STAND 12 IN. IN DIAM.)													
17	18	26½	7	S ⅜	35.86	33.0	192.5	10.94	8.91	7.25	1.32	.029	— 1⅝
14–15	18	9	7	S ⅜	35.86	31.3	194.4	9.81	7.60	6.28	1.28	.028	— 3 11/16
19	18	26½	7	A-1	36.59	33.5	195.1	11.82	10.10	8.15	1.40	.031	43¾
20	18	9	7	A-1	36.59	33.3	194.7	10.25	8.04	6.44	1.23	.028	Top
21–22	22	26½	7½	A-1	44.38	33.5	193.8	8.13	10.39	8.63	1.68	.046	29⅞
30–31	22	9	7½	A-1	44.38	32.7	191.9	8.81	9.82	8.03	1.25	.040	— ¼
26–27–28	26 Strt.	26½	7½	A-1	44.38	31.0	194.6	6.00	7.95	6.49	1.25	.048	3⅝
29	26 Strt.	9	7½	A-1	44.38	32.0	194.5	6.32	7.01	5.81	1.05	.040	— ¼
GROUP C—COMPARISON OF SIZES OF STANDARD NOZZLES													
17	18	26½	7	S ⅜	35.86	33.0	192.5	10.94	8.91	7.25	1.32	.029	— 1⅝
5	18	26½	7¼	S none	44.18	25.7	170.0	6.50	6.10	4.97	1.34	.034	21¼
2	18	26½	8	S ⅜	47.26	29.0	185.9	6.44	7.36	5.98	1.58	.041	2 11/16

* Standard nozzles designated by the letter "S"; Annular nozzles by the letter "A" followed by a number identifying the particular type of nozzle employed.
† Draft efficiency equals draft in pounds divided by exhaust pressure. ‡ Exhaust missing the top of the stack is indicated by negative values.

TABLE II

Run No.	Running time, hrs.	Train: No. cars	Train: Tons	Per cent total draft required: Under diaphragm	Per cent total draft required: Through tubes	Per cent total draft required: Through fire	Water: Pounds	Water: Temp., deg. F.	Equiv. evap. per sq. ft. h. s. per hr.
1	15	16	17	18	19	20	24	25	26
GROUP A—COMPARISON OF BRIDGE AND NO BRIDGE IN STD. NOZZLES (EXHAUST STAND 12 IN. IN DIAM.)									
17	.40	9	600.5	18.6	66.6	14.8	21,925	57.0	13.69
18	.43	9	600.5	19.5	62.8	17.7	23,700	55.0	13.78
11	.50	9	602.9	16.3	63.7	20.0	23,775	51.5	11.93
10	.45	9	602.9	18.0	61.5	20.5	22,950	53.0	12.78
14–15	.43	9	602.9	17.4	65.6	17.0	24,887	56.0	14.32
16	.45	9	602.9	17.9	65.3	16.8	22,925	56.0	12.73
GROUP B—COMPARISON OF LENGTH OF INSIDE STACK EXTENSIONS (EXHAUST STAND 12 IN. IN DIAM.)									
17	.40	9	600.5	18.6	66.6	14.8	21,925	57.0	13.69
14–15	.43	9	602.9	17.4	65.6	17.0	24,887	56.0	14.32
19	.43	9	600.5	19.3	66.8	13.9	22,700	55.0	13.21
20	.40	10	605.1	19.9	64.8	15.3	21,750	54.0	13.61
21–22	.39	10	605.1	16.9	66.8	16.3	22,950	52.0	14.59
30–31	.41	12	618.1	18.3	68.9	12.8	24,775	54.0	14.96
26–27–28	.42	12	640.1	18.3	65.8	15.9	21,958	60.7	12.92
29	.42	12	639.5	17.1	67.9	15.0	22,100	60.0	13.10
GROUP C—COMPARISON OF SIZES OF STANDARD NOZZLES									
17	.40	9	600.5	18.6	66.6	14.8	21,925	57.0	13.69
5	.57	16	618.2	18.5	59.5	22.0	.....	.....	.....
2	.47	16	618.2	18.7	59.8	21.5	.....	.....	.....

TABLE III—COMPARISON OF NOZZLE STYLES AND SIZES OF STACKS

Run No.	Stack: Diam., in.	Stack: Length inside extension, in.	Nozzle: Act'l or equiv. diam., in.	Nozzle: Style and diam. bridge	Area	Speed, M. P. H.	Pressure, lb. per sq. in.: Boiler	Pressure, lb. per sq. in.: Exhaust	Draft, in. water: Front end	Draft, in. water: Back of baffle	Draft, in. water: Firebox	† Draft efficiency	‡ Exhaust jet striking, in. from top of stk.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
5	18	26½	7½	S none	44.18	25.7	170.0	6.50	6.10	4.97	1.34	.034	21¼
21–22	22	26½	7½	A-1	44.38	33.5	193.8	8.13	10.39	8.63	1.68	.046	29⅞
23	26	26½	7½	A-1	44.38	30.0	191.0	6.17	8.31	7.04	1.25	.048	— ½
26–27–28	26 Strt.	26½	7½	A-1	44.38	31.0	194.6	6.00	7.95	6.49	1.25	.048	3⅝
39–40*	24	26½	7½	A-2	44.39	32.1	197.4	6.97	10.15	8.56	1.59	.052	39⅜
41–42*	24	26½	7½	A-3	44.32	32.1	192.1	7.57	11.52	9.51	1.57	.055	35 7/16
68–69	24	26½	7½	A-3	44.32	31.8	199.5	8.12	11.94	9.77	1.58	.053	39⅜
43*	24	26½	7½	A-4	44.22	32.1	200.0	9.29	11.70	9.64	2.11	.045	35 9/16
72–73*	24	26½	7½	A-4a	44.23	32.0	200.1	9.00	12.79	10.50	2.04	.051	35⅞
64–65	20	26½	7½	A-5	44.26	31.9	195.7	7.90	8.77	7.39	1.51	.040	42⅞
54–55	22	26½	7½	A-5	44.26	31.9	195.3	8.77	9.74	8.24	1.74	.040	— 3/16
47–49	26	26½	7½	A-5	44.26	29.9	194.2	7.01	8.79	7.36	1.70	.045	— 2¼
66	20	26½	7½	A-6	44.32	31.6	196.1	9.07	9.91	8.37	1.54	.039	— 3/16
52–53	22	26½	7½	A-6	44.32	32.0	196.8	8.79	10.20	8.50	1.69	.042	— 2 1/16
50–51	26	26½	7½	A-6	44.32	31.2	195.8	7.72	9.29	7.85	1.74	.043	— 4⅞
56–57	26	26½	7½	A-8	44.12	31.3	197.0	8.38	10.75	8.96	1.70	.046	41 5/16
58–59–60	26	26½	7¾	A-9	47.35	30.4	195.0	6.16	7.87	6.72	1.45	.046	— ½
61–62	26	26½	7¾	A-10	47.12	30.2	195.8	5.36	7.65	6.58	1.47	.051	— 1⅜

* Flare of stack increased on these runs. † Draft efficiency equals draft in pounds divided by exhaust pressure.
‡ Exhaust missing the top of the stack is indicated by negative values.

TABLE IV—COMPARISON OF NOZZLE STYLES AND SIZES OF STACKS

Run No.	Running time, hrs.	Train: No. cars	Train: Tons	Per cent total draft required: Under diaphragm	Per cent total draft required: Through tubes	Per cent total draft required: Through fire	Vacuum between nozzle ports, in. water (see Fig. 18): A	Vacuum between nozzle ports, in. water (see Fig. 18): B	Vacuum between nozzle ports, in. water (see Fig. 18): C	Water: Pounds	Water: Temp., deg. F.	Equiv. evap. per sq. ft. h. s. per hr.
1	15	16	17	18	19	20	21	22	23	24	25	26
5	.57	16	618.2	18.5	59.5	22.0	.....	.....	.....	.....	.....	.....
21–22	.39	10	605.1	16.9	66.8	16.3	.....	.....	.....	22,950	52.0	14.59
23	.45	11	637.4	15.3	69.7	15.0	.....	.....	.....	23,925	52.5	13.32
26–27–28	.42	12	640.1	18.3	65.8	15.9	.....	.....	.....	21,958	60.7	12.92
39–40	.42	15	628.2	15.7	68.7	15.6	22.41	24.83	19.21	22,975	64.0	13.41
41–42	.42	14	629.7	17.4	69.0	13.6	18.71	18.33	16.63	23,125	64.0	13.50
68–69	.40	14	635.2	18.2	68.6	13.2	17.36	19.59	20.47	23,025	69.0	14.25
43	.42	14	653.1	17.6	64.4	18.0	22.89	31.62	24.44	22,650	63.0	13.40
72–73	.40	14	635.2	17.8	66.2	16.0	20.08	20.76	19.69	20,963	69.3	12.96
64–65	.41	14	624.1	15.6	67.1	17.3	11.15	15.04	13.58	22,425	69.5	13.54
54–55	.40	13	634.8	15.4	66.8	17.8	10.77	12.42	10.77	23,238	66.5	14.23
47–49	.44	15 and 14	632.2	16.2	64.5	19.3	9.21	11.87	8.98	22,938	69.5	12.88
66	.40	14	624.1	15.6	68.9	15.5	8.53	10.86	10.67	22,175	70.0	13.70
52–53	.39	14	627.6	16.7	66.7	16.6	9.90	12.03	10.28	21,700	69.8	13.58
50–51	.42	14	628.0	15.5	65.7	18.8	9.35	10.67	9.35	21,788	69.0	12.83
56–57	.41	14	634.8	16.6	67.6	15.8	12.12	14.55	13.29	23,200	68.0	13.84
58–59–60	.43	15 and 14	632.7	14.6	66.9	18.5	7.76	9.83	8.99	21,367	66.8	12.45
61–62	.42	14	611.5	13.9	66.9	19.2	7.66	10.77	9.80	21,300	66.3	12.43

a draft of 8.91 in. of water and a draft efficiency of 0.029, the best results secured from a 7-in. diameter standard nozzle with a 3/8-in. bridge. This initial favorable showing of the annular type nozzle led to further developments of the design, which will be introduced later.

COMPARISON OF STANDARD NOZZLES OF DIFFERENT SIZES

Group *C* in Table I shows a comparison of the results of different sizes of standard nozzles, which, while not of particular interest in connection with improvement in the performance of the locomotive, suggests the limitations that would have been encountered had development been restricted to the standard type of nozzle. The highest draft efficiency obtained from the standard nozzles was with the 8-in. diameter nozzle with a 3/8-in. bridge, where a draft efficiency of 0.041 was secured, but it is observed in securing this draft efficiency that the draft itself was too low (7.36 in. of water) for the successful performance of the locomotive.

The results of run No. 5 give the performance of the 7½-in. standard nozzle without a bridge, used in connection with an 18-in. stack and 26½-in. inside extension, from which a draft of 6.10 in. of water and a draft efficiency of 0.034 were obtained. From these results, when contrasted with the results obtained from nozzle style A-1 with area equivalent to a 7½-in. diameter circle (group *B*, runs No. 21-22), where a draft of 10.39 in. of water and a draft efficiency of 0.046 were secured, the value of the annular type nozzle becomes apparent. The exhaust stack diagrams for these runs are shown in Figs. 5 and 7. In Fig. 5 it will be noticed that, for run No. 5 with the standard 7½-in. nozzle, the exhaust column was striking 21¼ in. from the top of the stack. In Fig. 7 for runs No. 21-22, the exhaust column was striking 29⅞ in. from the top of the stack, which shows there was a similar relationship between the exhaust column and the stack, and further leads

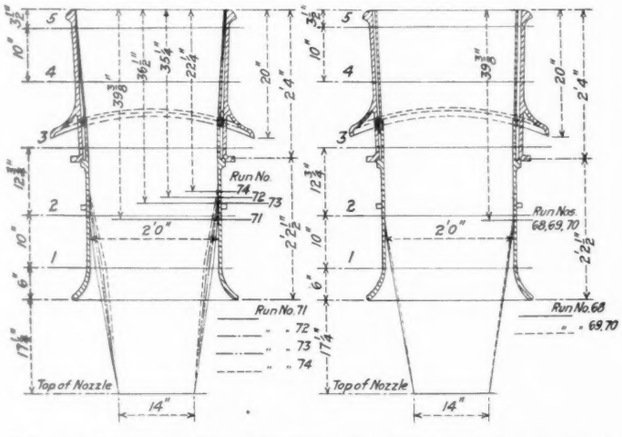


Fig. 11—Exhaust Stack Diagrams for Runs 68, 69-70, 71, 72, 73 and 74

to the conclusion that the marked difference in draft results was due directly to the special type of annular nozzle used.

COMPARISON OF STYLES OF NOZZLES AND SIZES OF STACKS

In consideration of data already presented the conclusion was reached that the standard nozzle gives the best results when used with a 3/8-in. bridge, and further that the best draft conditions were obtained when a 26½-in. inside extension was used. An effort will now be made to further consider how draft conditions are affected by the diameter of the stack and the particular type or style of nozzle used. For this purpose, Table III has been prepared in which, with but two exceptions, only nozzles equivalent to a 7½-in. diameter circle were used, and where in each instance 26½-in. inside stack extensions were employed. The results from run No. 5, in which the locomotive was equipped with an 18-in. diameter stack and a 7½-in. standard nozzle without a bridge, are shown in the first line of the table for comparison with the other combinations of annular nozzles and stacks. The results of runs No. 21-22 are again shown to afford further comparisons. During run No. 23, a 26-in. diameter stack was used with the same inside extension and size of nozzle as used in runs No. 26-27-28, where a 26-in. diameter straight stack was employed. With the standard taper stack the draft obtained was slightly improved, while

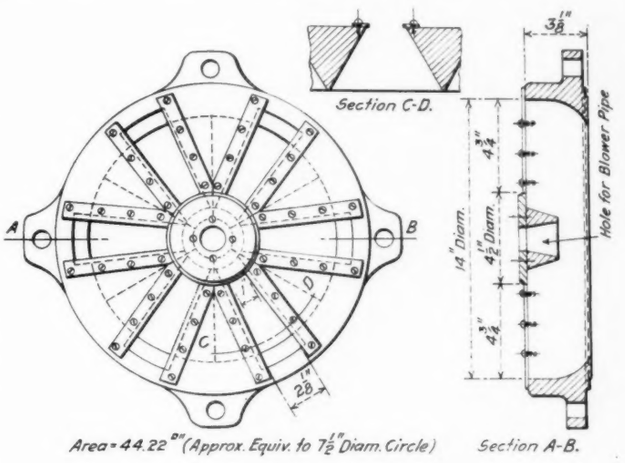


Fig. 12—Annular Nozzle A-4

the draft efficiency under each condition was identical, which leads to the conclusion that no advantage was gained by using the straight stack. The exhaust stack diagrams for these two sets of runs is shown in Fig. 7.

The satisfactory results from nozzle style A-1 encouraged further investigation along this line, and nozzle style A-2 was developed. This is illustrated in Fig. 8. It should be noted that the center opening shown in this drawing is provided to accommodate a central blower pipe and is not a nozzle port.

The theory followed in designing these nozzles on a larger external circle with the exhaust opening divided into annular ports, was to afford greater opportunity for the entrainment of the combustion gases by increasing the external surface of the exhaust column which is exposed for contact with the gases. Hence, in the design of nozzle style A-2 it was constructed on a 14-in. external circle, which is two inches larger than that of nozzle style A-1. Furthermore, the annular ports, instead of conforming in shape to a vertical section through a frustum of a cone, have been provided with side or wing extensions. The shape of the ports in this nozzle suggested the name "waffle iron" nozzle, by which it is now generally known. The 14-in. diameter nozzle was constructed so it could be applied to the 12-in. diameter exhaust stand installed before run No. 12 was made.

Waffle iron nozzle style A-2 was used with a 24-in. diameter stack on runs No. 39-40. Very satisfactory results were obtained from this combination; the draft in the front end averaged 10.15 in. of water and the draft efficiency was 0.052. The exhaust stack diagrams for these runs are shown in Fig. 9. In both of these runs the exhaust was striking well down in the stack, averaging 39⅝ in. from the top.

A further development of the annular nozzle is waffle iron nozzle style A-3, shown in Fig. 10. This nozzle is identical with style A-2 in every respect except that the

outside top surface of the nozzle is cored out between the annular ports. This was done for the purpose of providing additional opportunity for entraining the smoke box gases between the exhaust ports. That there was an entraining action at the top surface of the nozzle was demonstrated by the abrasive action of the cinders upon the surface of the nozzle between the ports. The intensity of the vacuum between the exhaust ports is shown in Table IV, columns No. 21, 22 and 23.

The results obtained from the use of nozzle style A-3, in combination with a 24-in. diameter stack and a 26½-in. inside extension, are shown as the average of runs No. 41-42 and as an average of runs No. 68-69. In the results from runs No. 41-42, attention should be directed to the relation between exhaust pressure and draft; the former is 7.57 lb. per sq. in. and the latter 11.52 in. of water, producing a draft efficiency of 0.055. These results might be compared with those obtained from the locomotive while equipped with the standard front end arrangement, where the exhaust pressure for run No. 17. Table I was 10.94 lb. per sq. in. while the draft was 8.91 in. of water and the draft efficiency only 0.029. The results from runs No. 68-69, which, except for a difference in the stack flare, had the same front end equipment as used in runs No. 41-42, varied slightly from the results of runs No. 41-42; the draft and exhaust pressure are both slightly higher and the draft efficiency slightly lower. The exhaust stack diagrams for runs No. 41-42 are shown in Fig. 9, and for runs No. 68-69 in Fig. 11. In both instances, the exhaust was striking well down in the stack, a distance of 35 7/16 in. from the top for runs No. 41-42, and 39⅜ in. for runs No. 68-69.

The successful results obtained from nozzle style A-3

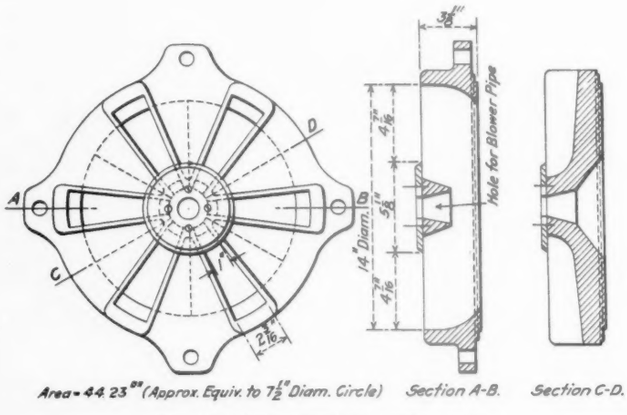


Fig. 13—Plain Annular Nozzle A-4a

raised the question as to whether the same satisfactory results might not be obtained from the same type of nozzle with plain annular ports, and nozzle style A-4 was improvised for this comparison. This nozzle, which is illustrated in Fig. 12, was cast off of the same pattern as nozzle style A-3 and the ports straightened by machining off excess metal entering within the bounds of the shape of the opening desired. Plates were then applied to bring the openings to the size desired. This nozzle was used in run No. 43 with the same stack combination as used in connection with waffle iron nozzle style A-3. While as satisfactory draft conditions were obtained, the average exhaust pressure was increased, resulting in a reduction in draft efficiency as compared with that obtained from nozzle style A-3. As both nozzles had the same free opening, there appeared no reason for increased exhaust pressure, unless the inwardly projecting edges of the plates used to restrict the ports to the dimensions required offered an increase in resistance to the passage of the exhaust, a condition which may be considered quite probable. It will be observed in Fig. 9 that the exhaust jet delivered by nozzle style A-4 was striking the stack at approximately the same position as in run No. 42, which run produced some of the best results obtained.

In a further effort to demonstrate the results that might be obtained from a plain annular exhaust port opening, nozzle style A-4a was cast with plain annular ports, as shown in Fig. 13. This nozzle featured in runs No. 72-73 and gave excellent results with respect to draft, but the high draft was accompanied by a high exhaust pressure, which resulted in a lower draft efficiency than was obtained from waffle iron nozzle style A-3. The exhaust stack diagram is shown in Fig. 11, where it is observed that the exhaust is striking the stack an average distance of 35⅞-in. from the top, a location for striking from which the best draft conditions have been obtained. It is difficult to reconcile the difference in exhaust pressure experienced with the plain annular nozzle as compared with the waffle iron nozzle, style A-3, since the latter is more irregular in contour and it seems would naturally offer more surface resistance to the passing of the exhaust.

(*To be Concluded.*)

THE MEANING OF W. S. S.

By JACK CUTLER

W.—Means We will win this war.
A.—America we are fighting for.
R.—Is for Right for which we stand.

S.—Is for Safety on sea or land.
A.—For our Army which never failed.
V.—For Victory which soon will be hailed.
I.—For Independence, America's aim.
N.—For our Navy of very great fame.
G.—Is for Glory which heroes attain.

S.—Is for Ships which are sailing around.
T.—Is for Tears in many homes found.
A.—For our Allies who will help win this war.
M.—For the Mothers who will grieve no more.
P.—Means Peace for one and all.
S.—Is for a Sound of the liberty call.

—*Pioneer Bulletin.*

MECHANICAL LABOR-SAVERS ON FRENCH RAILWAY.—Le Genie Civil says that the Orleans Railway, feeling the shortage of labor, has successfully adopted mechanical cleaning devices both for railway cars and hired cabs, in addition to vacuum cleaners. Various forms of revolving brushes driven at a speed of from 500 to 800 r. p. m., through flexible shafts by electric motors of 1-3 to 1-2 hp., are employed, the apparatus as a whole being slung, according to requirements, from various kinds of portable attachments, with the aid of springs and counterweights.

DAILY LOCOMOTIVE-MILES ON ENGLISH RAILWAYS.—A daily run of nearly 400 miles is the performance of a locomotive operating between London and Liverpool, according to the Railway Gazette, London. The trains in both directions are exceedingly heavy ones and long distances are run without stopping. The interval between the out and home journeys is, comparatively speaking, a short one. It is stated that this is but one instance of many, and until comparatively recently there were cases of the same locomotive and enginemen working from Manchester to London, a distance of 183.5 miles, and from Leeds to London, 220.5 miles, and back as a daily trip.

RAILROAD ADMINISTRATION ACTIVITIES

Administration's Policy Outlined; Interchange Inspection; Safety Work; Orders of Regional Directors

DURING the month the Director General has been in poor health and has found it necessary to arrange to spend the summer at White Sulphur Springs, Va. Although he will have an office at that point he will make frequent trips to Washington to oversee the work which he has detailed to his staff. In his absence, Walker D. Hines, assistant director general of railroads, will be in full charge.

Federal managers have been appointed to take charge of each property. The federal managers report to the regional directors, each of whom has a departmental organization of his own.

THE POLICY OF THE RAILROAD ADMINISTRATION

On June 15 the Director General gave out the following signed statement of the policy of the Railroad Administration:

"The policy of the United States Railroad Administration has been formed and shaped by a desire to accomplish the following purposes which are named in what I conceive to be the order of their importance:

"*First,* the winning of the war, which includes the prompt movement of the men and the material that the government requires. To this everything else must be subordinated.

"*Second,* the service of the public, which is the purpose for which the railways were built and given the privileges accorded them. This implies the maintenance and improvement of the railroad properties so that adequate transportation facilities will be provided at the lowest cost, the object of the government being to furnish service rather than to make money.

"*Third,* the promotion of a spirit of sympathy and a better understanding as between the administration of the railways and their two million employees, as well as their one hundred million patrons, which latter class includes every individual in the nation, since transportation has become a prime and universal necessity of civilized existence.

"*Fourth,* the application of sound economies, including:

(a) The elimination of superfluous expenditures.

(b) The payment of a fair and living wage for services rendered and a just and prompt compensation for injuries received.

(c) The purchase of material and equipment at the lowest prices consistent with a reasonable but not an excessive profit to the producer.

(d) The adoption of standardized equipment and the introduction of approved devices that will save life and labor.

(e) The routing of freight and passenger traffic with due regard to the fact that a straight line is the shortest distance between two points.

(f) The intensive employment of all equipment and a careful record and scientific study of the results obtained, with a view to determining the comparative efficiency secured.

"The development of this policy will, of course, require time. The task to which the Railroad Administration has addressed itself is an immense one. It is as yet too early to judge of the results obtained, but I believe that great progress has been made toward the goal of our ideals. All those who have had a share in this great work, including especially the members of my staff and the officers and employees of the railways, have shown intelligence, public spirit, loyalty and enthusiasm in dealing with problems that have already been solved and attacking those that still await solution.

"With their continued co-operation, I feel assured of a future in which the lessons of our accumulating experience will be effectively employed to humanize the science of railroading and negative the idea that corporations have no souls."

INTERCHANGE INSPECTION

To the end that interchange inspection work may not be duplicated under government operation of railroads, so that more repair work will result, the Division of Operation has ordered, in Circular No. 7:

1. That joint arrangements shall be made to prevent such duplication in inspection by arranging all inspection forces at interchange points with a head or chief joint inspector as conditions require, to supervise the forces and see that inspection and repairs are properly made to cars.

2. Present M. C. B. Rule No. 2 is modified as follows:

(a) Loaded cars offered in interchange (except those having defective safety applicances) must be accepted by the receiving line, which may either run, repair or transfer lading from car.

(b) The repairs to car or transfer of lading is to be done by the railroad having facilities nearest available. If facilities are equally available by both railroads, the car will be moved to facilities located in the direction car is moving.

3. If car is shopped for repairs due to:

(a) Old defects that existed before car was loaded—.

(b) Lading requiring transfer or readjustment on account of not being in accordance with M. C. B. Loading Rules—.

(c) Overload requiring transfer of lading—.

(d) Not being within clearance dimensions over route it is to pass—.

(e) Not meeting A. R. A. third rail clearance—.

The facilities nearest to car will be used in making repairs to car or transfer of lading.

4. Should the location of facilities require a receiving line to make transfer, the delivering line will not be billed for transfer or readjustment of lading, but the chief joint or head inspector will make report and forward to the head of the mechanical department of both railroads. The railroad responsible for conditions making necessary the shopping of car for old defects or transfer of lading, will impose discipline for willful and inexcusable violation of M. C. B. Rules of Interchange and Loading, and A. R. A. Rules, the same as instructed in director general's Order No. 8, for violation of safety appliance law.

5. Cars whether loaded or empty having safety appliance defects will have such defects repaired immediately upon discovery and will not be offered in interchange. If necessary to move a car to shops for repairs of safety appliance defects, it must be moved to shops of the company upon whose line it became defective.

6. Empty cars offered in interchange, if in safe and serviceable condition, must be accepted.

7. Bad order cars which previously had been delivered in bad order under load must be repaired by the road making transfer, if it has facilities and material; if not, the nearest repair point on any line, having material and facilities, should make the repairs.

8. With these modifications, owners must receive their own cars when offered home for repairs at any point on their

lines where the repair facilities and material are available.

9. Such inspectors as are now engaged on duplicate work will be assigned to repair work so as to insure maximum safety of operation and prompt movement of traffic.

SUPPLEMENT TO THE WAGE ORDER

The Director General has issued the following Supplement No. 1 to General Order No. 27:

"The following will be added as general rules to Section F, Article II:

"(14) For positions created since December, 1915, the salaries will be readjusted so as to conform to the basis established in General Order No. 27, for positions of similar scope of responsibility.

"(15) Where wages were increased through arbitration or other general negotiations, which cases were definitely closed out prior to December 1, 1915, but which for any reason were not put into effect until after January 1, 1916, the increases fixed by General Order No. 27 will be applied to such basis of wages as if they were in effect in December, 1915."

BOARD OF ADJUSTMENT NO. 2.

In conformity with the provisions of General Order No. 29, Railway Board of Adjustment No. 2 has been constituted as follows: W. H. Penrith, assistant general manager, Chicago & Alton; E. F. Potter, assistant to general manager, Soo Line; A. C. Adams, superintendent of shops, New York, New Haven & Hartford; E. A. Sweeley, master car builder, Seaboard Air Line; W. S. Murrian, formerly superintendent of motive power of the Southern; Robt. J. Turnbull, inspector of transportation, Atlantic Coast Line; H. J. Carr, International Association of Machinists; George W. Pring, International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America; G. C. Van Dornes, International Brotherhood of Blacksmiths and Helpers; F. H. Knight, Brotherhood Railway Carmen of America; Otto E. Hoard, Sheet Metal Workers' International Alliance; and F. J. McNulty, International Brotherhood of Electrical Workers. E. F. Potter, of the Minneapolis, St. Paul & Sault Ste. Marie, was chosen chairman, and F. J. McNulty, of the International Brotherhood of Electrical Workers, as vice-chairman. The board has designated the following dates as the beginning of each of its regular monthly meetings during the remaining portion of the year, 1918; July 2, Aug. 6, Sept. 3, Oct. 1, Nov. 5, and Dec. 3.

ORDERS OF REGIONAL DIRECTORS

SOUTHERN REGION

Circular Letter No. 243 states that each shop repairing foreign line locomotives will be expected to give such work the same supervision, inspection and workmanship that is given their own locomotives. Therefore the practice of sending inspectors to supervise repairs to locomotives at foreign line shops will be discontinued. It has been found to be of practically no value, and in some instances has actually resulted in delaying the repairs. When a locomotive is sent to a foreign line shop for repair the road sending the locomotive will furnish all necessary material for repairs; and will also furnish to the railroad which will make the repairs a detailed report of the work to be done, and a complete list of the material which is being furnished. The material shall in all cases be forwarded with or in advance of the locomotive. Inspectors at foreign line shops should be recalled and assigned to their regular work. The foregoing is not intended to apply to locomotives undergoing repairs at contract shops, or at the plants of locomotive builders, nor is it intended to apply to men who are specially assigned to work of collecting and forwarding necessary materials for repairs.

WESTERN REGION

Circular 121, dated June 6, orders that no contracts for repair of cars be placed at outside shops without first securing the approval of the regional director. The Car Repair Section is making an extensive inquiry and will be prepared to undertake necessary car repair work which cannot be done in the railroads' own shops.

Supplement No. 1 to Circular No. 121, issued on June 14, asks railroads to report the number of contracts with outside companies for repairing cars and the number of cars by classes undergoing such repairs. Copies of the contracts are also asked for together with a statement of the average cost per car for repairs on each contract, apportioned according to the cost of the labor, the material furnished by the contractor and the material furnished by the railroad to the contractor.

In a communication to western railroads on June 4, the regional director announces that railroads which have subscribed in the past to publications for the benefit of employees may continue in the same general policy but shall not radically increase or decrease number of subscriptions.

In Circular R. P. C. 14, dated June 8, the regional purchasing committee calls attention to the scarcity of tin and the necessity for conserving it to the fullest extent. The letter shows how less tin can be satisfactorily used in babbitt and solder for railroad uses. The regional purchasing committee asks western railroads to report any experiments that may further conservation.

In a communication to western roads, dated June 12, the announcement is made that the Director General authorizes each of the railroads under federal control to purchase one membership in the American Society for Testing Material.

A communication, dated June 21, outlines the specifications for United States standard interchangeable electric headlight, which is being placed on all the standard locomotives recently ordered by the Railroad Administration. The blueprints and wiring diagrams are not yet available, but will be distributed shortly. Each headlight equipment will consist of one 500-watt, 32-volt turbo-generator, one micrometer lamp stand and one dimming device, the case to be air tight, round headlight case, No. 22 U. S. S. gage steel, with copper (32-oz.) triple-plated reflector, 18 in. in diameter and 9 in. deep, and an automatic circuit connector complete. The headlight will be of the incandescent lamp type, conforming to the requirements of the Interstate Commerce Commission in an order dated December 26, 1916. The socket for supporting the headlight will be located at the rear of the reflector and will support the headlight lamp in a horizontal position, so mounted that it can be moved in any direction with fine adjustment, to permit of focusing the headlight lamp and locking in any position. Suitable electric connections must be provided so that on removing the reflector from the headlight case the circuits will be broken automatically and, in replacing, it will be made automatically. A small unit incandescent lamp will be provided in the headlight case for illuminating the locomotive number. Headlight dimming resistance of rugged construction to withstand severe operating conditions will be provided with each turbine generator equipment.

EASTERN REGION

In a letter, dated May 21, 1918, A. H. Smith, regional director, commenting on Rules 29 and 31 of the Federal Locomotive Inspection Rules, regarding locomotive headlights, writes as follows to the presidents of Eastern railroads:

"It is understood that some of the roads in Eastern territory are not complying with the provision of this order pending the outcome of court proceedings.

"The director general has instructed that the order should

not be modified, and that the railroads should proceed in good faith to carry out the terms of the order, i. e., that locomotives shopped for general repairs should be equipped with electrical headlights, that any new locomotive should be so equipped, and that the work should be followed diligently. Please be governed accordingly.

"If, after a trial, it is found that this work is adversely affecting shop output, or that headlights in sufficient quantities are not obtainable, the fact should be promptly brought to my attention.

"The locomotives which have been ordered by the Railroad Administration are all to be provided with electric headlights, conforming to the requirements of the Interstate Commerce Commission's order."

THE CAR AND LOCOMOTIVE SPECIALTY ORDERS

The Central Advisory Purchasing Committee of the Railroad Administration has ordered the principal specialties to be used for the equipment of the locomotives and the freight cars, ordered. In some cases the equipmenut is to be furnished or purchased by the builders, and in all cases formal orders will be placed by the car and locomotive builders with the specialty manufacturers. The list of the specialties so far ordered, which is practically complete, is as follows:

LOCOMOTIVES

Air brakes	775	Westinghouse Air Brake Co.
	250	New York Air Brake Co.
Brick arches	To be purchased by builders.	
Radial buffers	Franklin Railway Supply Co.	
Pilot bumpers	To be purchased by builders.	
Cradle castings	To be purchased by builders.	
Blow-off cocks	725	Everlasting, Scully Steel & Iron Co.
	300	Southern, So. Loco. Valve Gear Co.
Boiler covering	To be purchased by builders.	
Uncoupling devices	All engines. Imperial, Imp. Appliance Co.	
Automatic fire doors	590	Shoemaker, Nat. Ry. Devices Co.
	435	Franklin.
Friction draft gear	All	engine tenders. Westinghouse Air Brake Co.
Valve gear	500	Walschaert.
	340	Baker.
	185	Southern.
Reverse gear	745	Ragonnet.
	200	Lewis.
	50	Brown.
	30	Mellin.
Headlight turbines and generators	All engines. Pyle Nat. Elec. Head. Co.	
Steam gages	510	Ashcroft Manufacturing Co.
	515	Ashton Valve Co.
Steam heat gages for passenger engines	90	Ashton Valve Co.
Water gages	All engines. Sargent Co.	
Injectors	480	Nathan Manufacturing Co.
	395	Hancock Inspirator Co.
	150	Ohio Injector Co.
Check valves and stops	All engines. Nathan Manufacturing Co.	
Lubricators	600	Nathan Manufacturing Co.
	425	Detroit Lubricator Co.
Driving box lubricators	All engines. Franklin Railway Supply Co.	
Metallic packing	555	Paxton-Mitchell Co.
	470	United States Metallic Packing Co.
Coal pushers	250	Locomotive Stoker Co.
Regulators for passenger locomotives	65	Vapor.
	25	Leslie.
Bellringers	All engines. Harry Vissering & Co.	
Sanders	755	United States Metallic Packing Co.
	220	Hanlon Locomotive Sander Co.
	50	Harry Vissering & Co.
Stokers	570	Duplex, Locomotive Stoker Co.
	170	Standard Stoker Co.
	35	Hanna Locomotive Stoker Co.

(Switching and Pacific types take coal pushers.)

Blower valves	All engines, Sargent Company.	
Safety valves	640	Consolidated Safety Valve Co.
	330	Coale.
	55	Ashton Valve Co.
Brake shoes	All engines. American Brake Shoe & Foundry Co.	
Grate shakers	All engines. Franklin Railway Supply Co.	
Boiler tubes	To be purchased by builders.	
Unit safety draw bar	All engines. Franklin Railway Supply Co.	
Metallic connection between engine and tender	400	Franklin Ry. Supply Co.
	385	Barco Mfg. Company.
	240	Greenlaw Mfg. Co.
Springs	To be purchased by builders.	
Throttle valves	All, Chambers Valve Company.	
Rolled steel wheels	Forged Steel Wheel Company. Standard Steel Works Company.	
Coal sprinklers	540	William Sellers & Co.
	485	Hancock Inspirator Co.
Yokes for tenders (cast steel)	All, Buckeye Steel Castings Co.	
Side frames for freight engine tenders	American Steel Foundries. Buckeye Steel Castings Co.	
Tender truck bolsters	All engines. Pittsburgh Steel Foundry Co.	
Journal box for tenders	To be purchased by builders.	
Side bearings for tenders	All, A. Stucki Company.	
Brake beams for tenders	All, Chicago Railway Equipment Company, except 170 to be furnished by the Baldwin Locomotive Works.	

FREIGHT CARS

Truck bolsters	46,000	American Steel Foundries.
	21,000	Buckeye Steel Castings Co.
	21,500	Scullin Steel Co.
	8,000	Gould Coupler Co.
	3,000	Bettendorf Co.
Couplers	23,000	American Steel Foundries.
	15,500	Buckeye Steel Castings Co.
	7,500	Gould Coupler Co
	8,000	McConway & Torley Co.
	46,000	National Malleable Castings Co.
Side frames, cast steel	35,000	American Steel Foundries.
	14,500	Buckeye Steel Castings Co.
	16,000	Scullin Steel Co.
	6,500	Gould Coupler Co.
	28,000	Bettendorf Co.
Uncoupling device for couplers.	All cars, Imperial Appliance Co.	
Pressed steel ends	50,000	Pressed Steel Manufacturing Co.
Friction draft gear	50,000	Sessions, Standard Coupler Co.
	25,000	Westinghouse Air Brake Co.
	19,000	Cardwell, Union Draft Gear Co.
	6,000	Murray, Keyoke Railway Equip. Co.
Dust guards	All cars, Wm. N. Thornbergh Co.	
Air brake hose	To be furnished with air brake equipment.	
Brake shoes	All cars, American Brake Shoe & Fdy. Co.	
Draw bar yokes	50,000	Union Draft Gear Co.
	50,000	Buckeye Steel Castings Co.
Air brakes	75,000	Westinghouse Air Brake Co.
	25,000	New York Air Brake Co.
Brake beams	14,250	American Steel Foundries.
	14,250	Chicago Railway Equipment Co.
	14,000	Joliet Railway Supply Co.
	14,000	Davis Brakebeam Co.
	14,000	Damascus Brake Beam Co.
	14,000	Buffalo Brake Beam Co.
	8,000	Haskell & Barker Car Co.
	7,500	Pressed Steel Car Co.
Steel ends for composite gondolas	12,000	Standard Railway Equipment Co.
	8,000	Chicago-Cleveland Car Roofing Co.
Side bearings	40,000	A. Stucki Co.
	30,000	E. S. Woods & Co.
	30,000	Wine Railway Appliance Co.
Journal boxes	32,500	Union Spring & Manufacturing Co.
	38,875	National Malleable Castings Co.
	28,500	T. H. Symington Co.
	16,125	Gould Coupler Co.
	4,000	American Malleable Co.
	8,000	Haskell & Barker Car Co.
	2,000	Pacific Car & Foundry Co. will secure on Pacific Coast.
Journal bearings	8,000	Haskell & Barker Car Co.
	10,000	Bostwick-Lyon Bronze Co.
	11,000	Southern Brass Company.
	20,000	Keystone Bronze Company.
	Balance of Order to be placed later.	
Wheels (steel)	3,000	Midvale Steel & Ordnance Co.
	7,500	Forged Steel Wheel Company.
	2,500	Carnegie Steel Company.
Wheels (cast iron)	15,750	Griffin Wheel Company.
	1,625	Brown Company.
	1,625	Buffalo Car Wheel Fdy. Co.
	2,000	Bass Foundry & Mach. Co.
	2,000	New York Car Wheel Wks.
	2,500	National Car Wheel Company.
	1,000	Ramapo Iron Works.
	1,000	Southern Wheel Co.
	500	Standard Steel Works Co.
	1,000	Albany Car Wheel Co.
	500	Louisville Car Wheel & Ry. Sup. Co.
	7,000	Pressed Steel Car Company.
	31,000	American Car & Foundry Co.
	8,000	Haskell & Barker Car Co.
	4,000	Mt. Vernon Car Mfg. Company.
	2,000	Lenoir Car Works.
Door fixtures	25,000	single sheathed box. Camel Company.
	25,000	double sheathed box. Union Metal Products Company.
Door operating mechanism	Composite gondola and 55 ton hopper cars. Combination of car builders design with Enterprise safety lowering device.	
Roofs	17,000	Murphy, Standard Ry. Equipment Co.
	16,500	Chicago-Cleveland Car Roofing Co.
	16,500	Hutchins Car Roofing Company.
	10,000	American Steel Foundries.
Springs	5,250	Crucible Steel Co.
	5,500	Union Spring & Mfg. Co.
	5,350	Pittsburgh Spring & Steel Co.
	2,400	Ft. Pitt Spring & Mfg. Co.
	52,000	Railway Steel Springs Co.
	3,000	W. G. Mitchell Spring Works.
	7,500	Pressed Steel Car Company.
	7,500	Standard Steel Car Company.
	1,500	Keith Ry. Equipment Company.
Angle cock holders	All, Railway Devices Company.	
Ratchet brake levers	For composite gondolas and 55 ton hoppers.	
	25,000	Robert H. Blackall.
	20,000	Railway Devices Company.

(The number in each case represents the number of cars or locomotives where two or three of a device is used on a single car or locomotive.)

The proposal which was tentatively advanced at the beginning of the negotiations with the specialty manufacturers

that they forego royalties on their patents or pool their patents was dropped.

AN UNUSUAL BOILER EXPLOSION

The reports of the chief inspector of locomotive boilers to the Interstate Commerce Commission show that in the six years covered by the statistics there have been 5 shell explosions, 335 crown sheet failures due to low water, and 19 explosions due to defective material, or water foaming. An explosion which will not fall strictly within any of these classifications is sufficiently unusual to merit notice.

The illustrations accompanying this article show two views of a locomotive on which low water caused the side sheet to fail, the crown sheet remaining in place. The locomotive was of the six-wheel switch type, with a narrow firebox. The crown sheet was practically flat and was supported by crown bars of a heavy T section and crown bar bolts with large heads. While operating in yard service the water level fell to a point about 18 inches below the crown sheet, resulting in the failure of the boiler as shown. The water line is clearly defined on the side sheet by the white horizontal line.

From an examination of the boiler it appears that some of the staybolts in the right side sheet near the upper front corner became overheated, together with the surrounding sheet, and pulled out. This caused a very great stress on the rivets connecting the wrapper sheet and the last course of the barrel of the boiler. The rivets at this point failed in tension, as can be seen by the character of the fracture. After the first rivets pulled out, the wrapper sheet was distorted, and the rivets in the barrel above the point where the initial failure occurred and those below in the throat sheet were sheared off. All the staybolts in the side sheet were either broken or pulled out. As the sheets separated the mud ring was pulled up and broke about a foot from the front corner. A patch about 12 inches wide extended along the bottom of the wrapper sheet for the entire length of the firebox. This was broken close to the throat sheet, failure occurring at the row of flexible staybolts. The back tube sheet was bent and pulled away from some of the tubes. Although the entire right side of the cab was demolished and the engineer was badly scalded by the escaping steam, he recovered from his injuries. The fireman was not hurt.

Wrapper Sheet Seam which Failed Due to Low Water

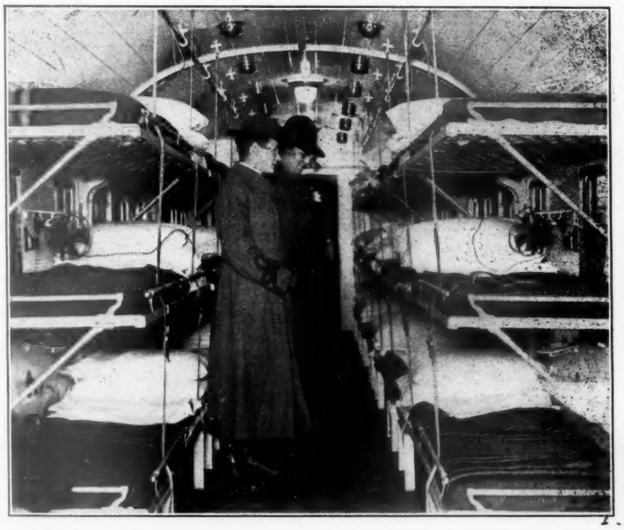
The fact that the crown sheet did not drop shows that the application of crown bars with large heads on the crown bar bolts furnishes ample support for the crown sheet, even with extremely low water. However, it is a question whether failure of side sheets would not often bring more serious results than ordinarily occur when a crown sheet fails.

Wrapper Sheet Torn from Barrel Due to Low Water

CAR DEPARTMENT

BRITISH AMBULANCE TRAIN FOR AMERICAN WOUNDED

If there were any doubts as to whether wounded American soldiers would be properly taken care of on their journeys by rail to the hospitals behind the lines in France, they have all been dispelled by the announcement made by Surgeon General Bradley with the American Army in France on January 6 that 15 complete hospital trains have been ordered in England and two in France for this purpose. The announcement followed the placing of the orders some time, for



Central News Photo

American Officers Inspecting the Accommodations

on December 29 the American ambassador, a number of United States Army and Navy officers and prominent Americans and Englishmen were able to inspect at the St. Pancras station in London, the first of the completed trains—one built in the car shops of the Midland Railway of England. In the Patriotic War Number of the Railway Age Gazette there appeared a description of one of the ambulance trains built for the British Government by the Great Eastern Railway, and emphasis was placed on the extreme care that the British have taken to make the railway journeys for their wounded as pleasant and restful as possible under the circumstances. The American train, illustrations of which are given herewith, likewise shows evidence of this British skill and care.

The complete train consists of 16 cars with accommodation for about 430 persons, there being 393 cots for wounded and facilities for the staff and personnel. Each car is 54 feet long, mounted on four-wheeled bogie trucks, and equipped with Westinghouse brakes. The couplings, draw hooks, steam connections and side chains are to the international standard. The total length of the train, without engine and tender, is 913 feet, and its weight (unloaded) 435 tons.

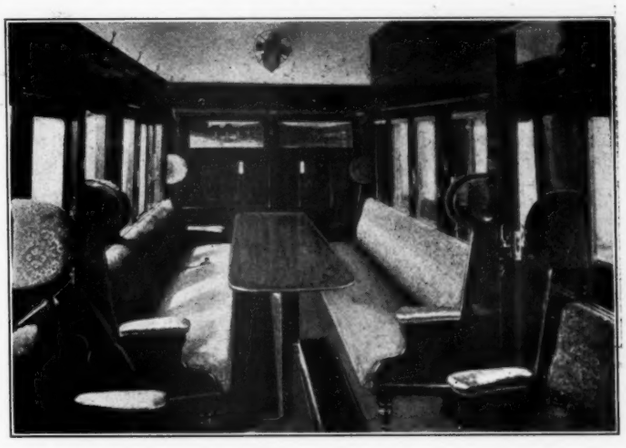
Each car is built of well-seasoned timber and painted khaki color, with two large red crosses on a white ground on either side. For identification purposes, the number of each car and the distinguishing letter are conspicuous on each side, and the train number with the distinguishing letters U. S. A. T. is painted on the extreme ends of the train.

The train is vestibuled, and fitted throughout with electric lights and fans. The roofs are semi-elliptical, with high and airy ceilings. Every care has been taken to admit of the interior of the cars being kept clean with the least effort. The floors are covered with linoleum or lead, and have rounded corners. The gangways between the cots are wide enough to pass the army stretcher. An abundant supply of water (2,835 gal.), apart from the drinking water, is carried in tanks built in the roof.

In addition to the equipment for heating the train by steam from the engine, the Staff car *B* and the Personnel car *C* have each a separate, self-contained circulating hot water apparatus for use when the engine is not attached.

The order of cars on the train is as follows:

A-10—Brake and "lying" infectious ward car.
B—Staff car.
D-1—Kitchen car (with officers' compartment).
A-1, *A*-2, *A*-3, *A*-4—Ward cars (four).
F—Pharmacy car.
A-5, *A*-6, *A*-7, *A*-8, *A*-9—Ward cars (five).



Sick Officers' Day Saloon

D-2—Kitchen car (with N. C. O.'s and men's compartment).
C—Personnel car.
E—Brake and stores car.

The brake and lying infectious ward car (*A*-10) contains four wards, each fitted with six beds, an attendant's compartment with lavatory and toilet accommodation, and a

guard's compartment with bed, folding table and seat, lavatory, etc., in addition to the usual brake equipment.

Staff car *B* contains dining room and sleeping compartments for the medical officers and nurses and lavatory and toilet accommodation, including side sprays. This car is also furnished with wardrobes, cabinets and book racks, and is finished and panelled throughout in polished mahogany.

Central News Photo

One of the Nine War Cars

Kitchen car *D*-1 contains an officers' pantry and cook's room, with three sleeping berths, dining table, seats, etc. The kitchen, which is a spacious compartment, is fitted with an army "Dixie" range with hot water supply, and a "Soyer" stove. A comfortably furnished sitting sick officers' compartment forms part of the kitchen car, having wood linings and tables of polished mahogany, and the seat coverings of moquette, with a lavatory compartment adjoining. A bath

The Kitchen Car

room is also provided in this car, containing a 4 ft. 6 in. bath, which is fitted with hot and cold water and shower bath.

The nine ward cars are open throughout, with a lavatory compartment at one end. Each car contains 36 folding cots, in three tiers, the cots in the middle tier being so arranged that they can be folded down to form backs for sitting cases on the lower tier. An ample supply of drinking water and conveniences such as paper racks, ash trays, etc., is provided for each patient. The sides and roofs of these cars are painted in glossy white enamel.

Pharmacy car *F* contains a dispensary, and treatment medical officer's office, linen room, and a pantry for medical comforts, and an emergency compartment. The corridor on this car is wide enough to pass a stretcher into the treatment room. The dispensary is fitted with cupboards and racks for bottles, surgical dressings, etc. Part of this car is partitioned off and provided with eight berths, in which bad cases can be treated.

Kitchen and men's mess car *D*-2 contains a large kit store, wash basin, and kitchen similar to that on car *D*-1, a mess room, with folding table for the men, and a smaller mess for the non-commissioned officers, the latter having two beds, so that the senior N. C. O.'s may sleep there if desired.

Personnel car *C* is arranged similarly to the ward cars, except that the mattresses of the beds are covered with Ameri-

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War Car Arranged for Sitting Cases

ican cloth, so that the beds can be used as seats by the staff during the day. Kit racks are provided, and also small lockers under the beds.

Brake and store car *E* contains a large linen store and a compartment provided with shelves for carrying the general provisions required on the train, a kit store and compartment for perishables and a meat safe. A brake compartment similar to that on car *A*-10 completes the car.

A STATEMENT OF THE PURPOSE OF THE M. C. B. ASSOCIATION*

BY JOSEPH W. TAYLOR
Late Secretary of the Master Car Builders' Association

The Master Car Builders' Association, in its beginning a voluntary organization, composed of master car builders and foremen of railway car shops, was formally organized at Altoona, Pennsylvania, September 18, 1867. Previous to this, and dating back as far as 1864, several informal meetings had been held by the car men of the New York Central, which were attended by the master car builders of a few of the nearby roads. At the meeting referred to, 41 master car builders were present, when a constitution and by-laws were adopted.

The objects of the association are the advancement of knowledge concerning the construction, maintenance and service of railroad cars and the parts thereof, by investigations through committees and discussions in convention; to provide an organization through which the members and the companies they represent may agree upon such joint

* The information contained in this statement was prepared for the Railroad Administration by Mr. Taylor shortly before his death.

action as may be required to bring about uniformity and interchangeability in the parts of railroad cars; to improve their construction and to adjust the mutual interest growing out of their interchange and repair, but the action of the association shall have only a recommendatory character, and shall not be bindng upon any of its members or the companies represented in it.

The reasons for the formation of this organization may be stated as follows:

Prior to the date of the organization cars were confined almost, if not entirely, to the roads for which they were built and to which they belonged. The inconvenience of transshipping freight when carried long distances soon made it necessary to run cars over more roads than one, and as the demand for carrying freight further without breaking bulk increased some improvement was necessary in order to carry it without unloading and as rapidly as possible. This brought into existence different express or fast freight lines which operated over two or more roads in different sections of the country. It was soon found that difficulties were constantly occurring in regard to the repairs of these cars, and that they were often delayed when far away from home by not having the right kind of materials on hand to replace broken parts. Some plan had to be devised to obviate the evil, and as the master car builder was deeply interested in the physical condition of the car, an organization of these men was effected to take care of the prompt repairs of the cars.

Up to the year 1882 the organization was wholly voluntary. It received no financial support whatever from the railroad companies which were the owners of the property intrusted to the care of the master car builders, and the improvement of which was the chief subject of consideration and discussion at their meetings, the expenses of the organization being met by assessments on the individual members. Neither were the railroads directly represented in the association, excepting by such exertions in behalf of their employees as the master car builder might choose to make, if he were a member. It was therefore thought that if the association was so organized that each railroad company could be represented by a vote in its deliberations proportionate to its interests, or, in other words, to the number of cars it owned, and if the work which the association had done and should do was adequately explained and understood by the chief executive officers of the railroads of the country, that they would be inclined to co-operate with the association and assist in its work. An amendment to the constitution was therefore introduced at the convention in June, 1881, the purpose of which was to create a new class of members, to be called "representative members" with the status and privileges indicated above.

As stated above, the proposed plan of reorganization of the association was submitted to the chief executive officers of the railroads of this country, Canada and Mexico, and received practically the unanimous approval of these officials, and at an adjourned meeting held at Niagara Falls, New York, on October 10, 11 and 12, 1882, the proposed reorganization was ratified and adopted.

At the present time the membership of the association is as follows:

Active	454
Representative	468
Life	19
Total	941

The number of cars represented in the association is practically 2,800,000 cars, the cars of Canadian and Mexican railways being included. Its membership extends to England, France, Russia, India, Australia, Japan, China, Argentina, Chili, Brazil, Cuba and the Philippines, officials of railroads in those countries wishing to avail themselves of the information contained in its proceedings relating to the construction and operation of cars.

As a result of the reorganization in 1882 the scope of the work of the Association developed and broadened materially. Through the financial support furnished by the railroad companies, investigations and tests of practically every part of a car have been, and are constantly being carried on, to furnish equipment of the necessary strength and designs to meet adequately the varying requirements of the traffic of the country.

The question of uniformity in the construction of cars whereby the parts of cars used by one railroad may be used in repairs of the cars of any other road has been constantly before the Association. As an indication of what has been accomplished in this direction, the following comparison of the number of parts necessary to keep on hand for repairs at the date of reorganization (1882) and the present time is cited:

	1882	1918
Axles	56	5
Journal boxes	58	5
Couplers	26	2
Brake shoes	20	1
Brake heads	27	1

The parts enumerated above are only a few of those used in the repairs of cars, but if they were all named, it would increase the list to enormous proportions. A similar condition of things to that indicated above exists wherever any considerable number of cars are interchanged between railroads.

Among the more important developments made by the Association, may be mentioned the adoption in 1887 of the automatic coupler for cars, thus doing away with the link and pin coupler and the necessity for going between cars to couple them together.

Another noted achievement was the adoption in 1888 of the automatic air brake as the standard of the Association. Today, practically every car in the country is equipped with this device.

Following its adoption, a code of instructions for the proper operation of the air brake was prepared and generally distributed among railway employees.

Through the activities of the different committees and their investigations and studies, standards for 62 different parts of cars have been adopted by the Association.

Other parts of cars are being studied and while no definite standards have been adopted, certain forms of recommended practice have been submitted to the members for investigations and trial, with the expectation that they, or some modification of them, will finally be adopted as standard and become the universal practice of the railroads.

The railroad car of today is simply a vehicle of transportation, no matter by what railroad it is owned. The object of the railroads today is to furnish a vehicle suitable for the lading, and transport that lading to destination as expeditiously as possible. The railroad car is subject to very severe handling in trains and certain defects naturally develop which need to be kept in repair. To take care of this condition, this association has formulated and maintains rules for the interchange of traffic, insofar as they relate to the physical condition of the car, so that the traffic itself may not be delayed. By these rules of interchange the immense movement of traffic between railroads is carried on with a minimum of delay due to the defective condition of the car.

The aim of the association through these interchange rules is:

(1) To establish rules which will uniformly permit of the prompt interchange of traffic between the various railroads without undue delay to the shipment of the car, which might be brought about by a difference of opinion between the receiving and delivering line as to responsibility for the physi-

cal condition of the car or the method of loading on open top cars.

(2) To provide through allowances, as given in the rules, prices to be charged for materials, detail times for completing the various items of repairs and a uniform labor rate per hour.

(3) Uniformity in compiling charges as between car owners for the maintenance of the equipment of the country.

(4) Fixed allowances to enable car owners properly to check bills for car repairs made against them by other handling companies.

(5) To provide methods for reimbursing car owners for the destruction or damage to their cars by other handling companies.

(6) The compulsory use by car owners of detail standards of construction as brought about through the operation of the rules, so that when the association feels that certain standards of construction are necessary for the safe operation of cars, they will not be permitted to be interchanged without the use of these standards.

(7) In 1887 an Arbitration Committee was established for the settling of disputes arising under the rules between members of the association in reference to a correct understanding of the rules with reference to car maintenance and also as to correctness of charges. During this period 1,133 cases have been arbitrated.

The association has promulgated rules for the loading of materials on open cars, thereby preventing the shifting of loads in transit and the consequent accidents therefrom.

The safety appliances approved by the Interstate Commerce Commission are our standards and the rules governing them are distributed to our members.

The association, working in conjunction with the Bureau of Explosives, has developed a series of specifications for the construction and operation of tank cars. The first specifications were prepared in 1903, and were principally for wooden underframe cars having tanks tested to but 40 lb. per square inch, and therefore, under the Interstate Commerce Regulations could not be used for the transportation of inflammable liquids with flash points below 20 deg. F. The next step was the development of a tank car for the handling of volatile inflammable products, to withstand a test of 75 lb. per square inch. The final development is a tank car for the transportation of such liquids as chlorine and sulphur dioxide, to withstand a test of 300 lb. per square inch. Tests of these tanks and their safety valves must be certified to the Bureau of Explosives before they are permitted to be used in service.

The income of the Association is derived by the assessment of the active members on the basis of $5 per year, and the representative members, or those appointed by the executive officer of the railroad, on the basis of $6 per 1,000 cars represented in the Association.

While the Association's activities are along the lines of the construction, maintenance and service of railroad cars, it also keeps in close touch with the Interstate Commerce Commission, the Bureau of Explosives, and also with other railway organizations, such as the American Railway Association, the Association of American Railway Accounting Officers, the various transportation associations, in its efforts to maintain the rolling stock equipment of our railroads in the highest state of efficiency.

In conclusion, it is respectfully submitted that to facilitate the movement of traffic, to handle the traffic safely, not only in reference to the movement of the load itself, but also to safely operate the railroads as a whole, to improve car construction, to allocate responsibility for freight car maintenance, a set of rules such as has been already developed is necessary. To apply such rules effectively an organization is necessary which should have sufficient flexibility in its authority to meet changing conditions promptly; the Master Car Builders' rules and organization provide the necessary vehicle for accomplishing such purpose.

PASSENGER CAR TERMINAL [illegible]*

BY C. V. FRYER
General Foreman, Car Department, New York, Ontario & Western

The passenger car terminal yard bears the same relation to the car shop that the roundhouse bears to the locomotive shop. It is the inspection point where a decision is made whether to make repairs or send the car to the shop. In some cases the foreman will send cars to the shop for some minor repairs, which should be attended to at the terminal. All light repairs, such as changing wheels, repairs to trucks, draft gear, air brake, steam heat and lighting equipment, that could be repaired in a few hours, should be taken care of at the terminal repair yard, also all light repairs to the interior, such as lamps, seats, watercoolers, hoppers (flush or dry), door locks, trap doors, window glass, sash balances, etc.

The terminal stock room is of considerable importance. It should be under the charge of an experienced car man if the terminal is large enough to warrant one; if not it should be under the supervision of the foreman, or the "handy man," that fellow who can turn his hand to most any kind of light repairs. He can be found in nearly any car repair shop. He should be transferred to the terminal yard and given a good rate, as he is a valuable man to the foreman and a big saver of time and material for the company.

The terminal foreman should be supplied with a record of all different series of cars, with a description of the fittings and appliances, size of journals and wheels, kind of draft gear and names of parts, kind of uncoupling apparatus, coupler, centering devices, side bearings and center plates, also the names of the interior fittings, such as hoppers, basket racks, sash balances and locks, door locks, seat fittings, etc.

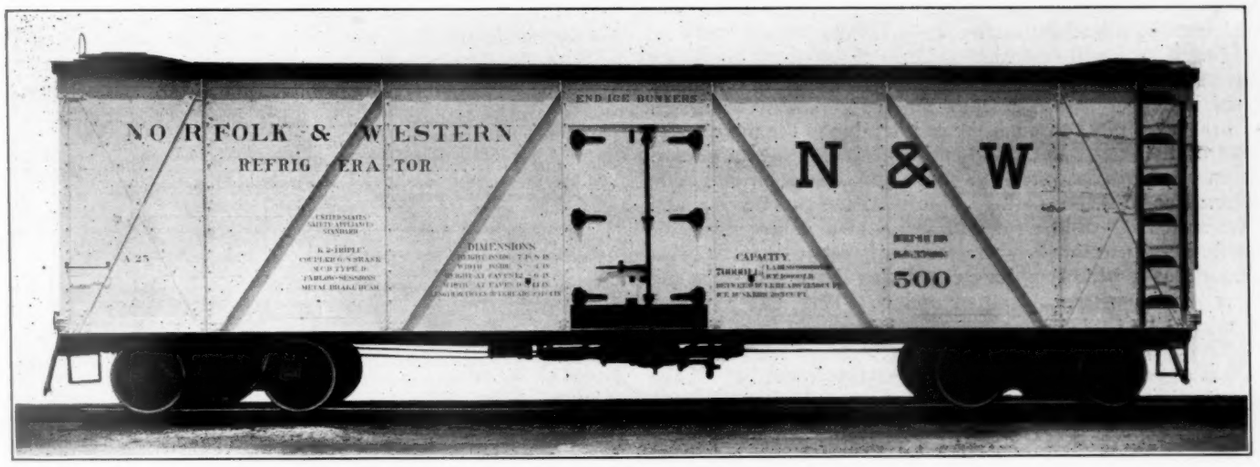
Much could be said about the layout of a terminal repair yard. It should have a good water system, a good steam heat and compressed air plant, a drop pit for removing wheels, a vacuum cleaning system, and a work shop for carpenters, tinsmiths, blacksmiths and pipe fitters.

The organization should be headed by a live foreman who understands car repairing in all its branches, and should have the necessary number of repair men and men who understand steam heat and air brake work. The size of the organization will depend, of course, upon the number of cars handled.

On the arrival of a train in the repair yard, a careful inspection should be made to see if any repairs that will require any car being switched out are necessary. Special attention should be given to steam heat, air brakes, trucks, draft gear and journal packing. The interior should be thoroughly looked over for loose seats, screws projecting from fittings and seat backs, water coolers should be thoroughly cleaned by scalding with steam, toilets scrubbed and disinfected, floors scrubbed, seats and backs dusted, the car wiped and windows cleaned inside and outside. To keep the good will of the traveling public, keep your cars clean.

MAGAZINES FOR SOLDIERS.—In the office of the station master at the Utica Union Station there is a great pile of magazines and reading matter. This literature was sent there by the Utica Public Library, which has been steadily collecting such material for some time, and the railroad men see to it that every troop train which passes through Utica is supplied with several bundles of the magazines. The Utica Herald-Despatch says that this is an excellent work, and the railroad men and the library are both to be congratulated.

*Presented at the convention of the Chief Interchange Car Inspectors' and Car Foremen's Association.



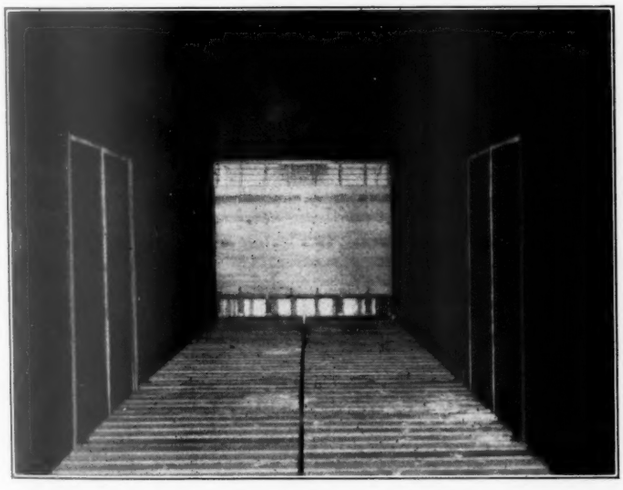
STEEL FRAME REFRIGERATOR CARS

Norfolk & Western Design Has Bunched Insulation, Insulated Bulkheads and Conduit Floor Racks

BY E. G. GOODWIN

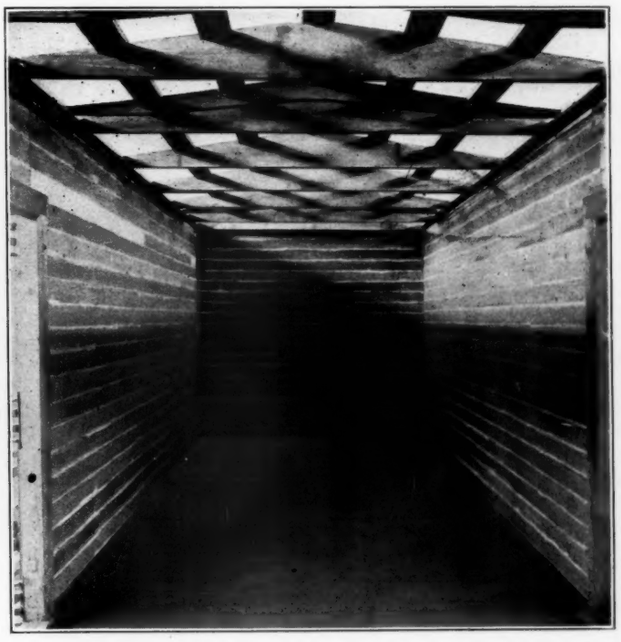
THE Norfolk & Western is constructing in its Roanoke (Va.) shops, as samples and for experimental purposes, ten refrigerator cars designed to meet, both scientifically and practically, all of the requirements in the transportation of perishable freight. Although these cars are just being constructed, the design was prepared in 1916, and as these are the first refrigerator cars built by the Norfolk & Western, a thorough study of the subject was made from every point of view, both theoretical and practical.

An investigation of the design of a large number of refrigerator cars showed that in the majority of cases many of the fundamental and well established principles of refrigeration and mechanics were entirely neglected. Perhaps the most notable deficiency in this respect is in the matter of the proper directing of the air currents. The keynotes of a successful refrigerator car lie in proper air circulation and insulation. It should be understood at the outset that ice meltage serves not only in lowering the temperature of the air inside of the car but that it furnishes also the motive power by means of which air circulation throughout the car may be obtained if the car is correctly designed.



Completed Interior of the Car with the Usual Type of Floor Rack

The solid bulkhead with which these cars are equipped provides an air leg or chimney, from the top and bottom of which it is both reasonable and practical to carry out conduits in such manner as to give circulation with uniform temperatures throughout the entire car. At the floor this is obtained by building the floor racks not only to provide the customary protection for the lading from damp floors, but to form an air conduit for the flow of cold air out to the center



Interior of the Car after the Application of the Sub Floor and Outside Sheathing

of the car. The warm air returns over the top of the lading and into the top of the air leg.

The distribution and method of application of insulation have undergone considerable change in the last few years. Experience has shown that by far the greater transmission of heat takes place through the ceiling, due to the more direct rays of the sun. It is also established that the insulation below any possible water line should be waterproof and little affected as to its insulating value if allowed to become wet. The customary dead air space between successive layers of insulation is practically worthless and in many cases a disadvantage, as it often becomes a circulating space, rendering the outer portion of the insulation useless. The more practical method of bunching the insulation is preferred, especially because the insulation is so easily supported to withstand the shocks of ordinary service, the smaller space required and the elimination of all air currents within the walls themselves.

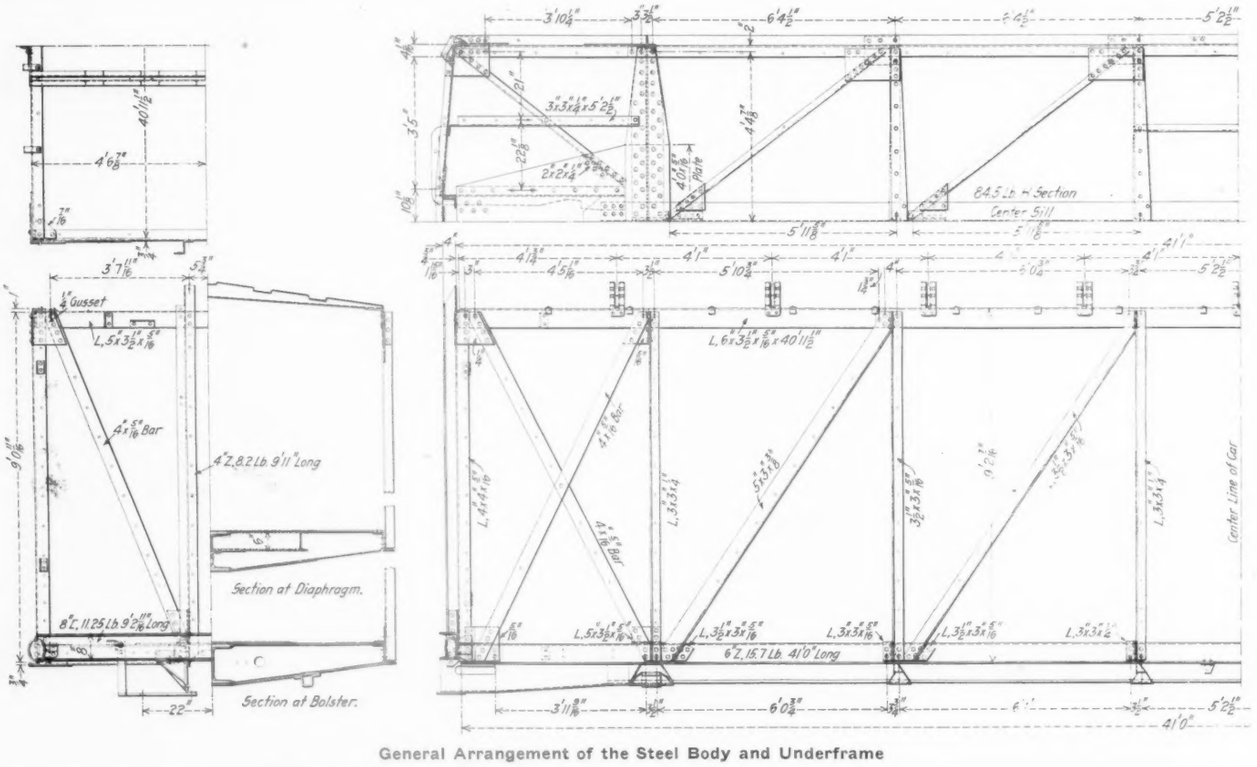
As a result of the preliminary study, some of the objects sought in the design were: An all steel frame sufficiently strong and rigid to prevent material deflection or wearing; means for holding the ice away from the car walls to reduce melting from the convection of the outside heat; unrestricted 10,000 lb. of ice, with a minimum space between the ice bunkers of 2,000 cu. ft.

With the above specifications the cars were designed to the following general dimensions:

Length between bulkheads	33 ft.	4 5/8	in.
Length over end sheathing	44 ft.	1	in.
Length over end sill channels	45 ft.	1 1/2	in.
Width inside	8 ft.	4 1/2	in.
Width over sheathing	9 ft.	1 3/4	in.
Width over steel framing	9 ft.	8	in.
Width over eaves	9 ft.	11 1/4	in.
Height inside, floor to ceiling	7 ft.	8 1/4	in.
Height of floor racks		5	in.
Height of floor from top of rail	4 ft.	9/16	in.
Height of running board	13 ft.	4 5/8	in.
Maximum height of car to top of brake shaft	13 ft.	10 3/4	in.
Width of door opening	4 ft.	3	in.
Height of center plate	2 ft.	3 5/8	in.
Truck centers	31 ft.		
Truck wheel base	5 ft.	6	in.
Size of journals		5 in. by 9	in.
Size of ice bunkers, each		132.5 cu.	ft.
Capacity { Lading		60,000	lb.
Capacity { Ice		10,000	lb.
Light weight		55,800	lb.

STEEL FRAMING

In view of the fact that the frame is the most essential part of the entire car from the standpoint of permanence and dura-


84.5 Lb. H Section
Center Sill
Section at Diaphragm.
Section at Bolster.
6"Z, 15.7 Lb. 41'0" Long
8"L, 11.25 Lb. 9'2 11/16" Long
4"Z, 8.2 Lb. 9'11" Long
Center Line of Car

General Arrangement of the Steel Body and Underframe

and properly proportioned passages for the air currents with ample contact area between the air and ice; a solid, insulated bulkhead to provide an air chimney and to prevent localization of refrigerating effects.

In view of the difficulty of obtaining a load of any material weight with most of the perishable goods in a car of reasonable cubical capacity, 60,000 lb. is probably the most practical capacity to which a refrigerator car should be built, but in the case of such a car, where the tare weight is so great, the standard 30-ton car trucks are not capable of carrying the dead weight of the car and 30 tons of lading. The next larger standard truck is required, which is a 40-ton car truck with five-inch by nine-inch journals. It was considered economical and practical, therefore, to proportion the parts of the car to carry possible loads representing the full capacity of the trucks, making a 70,000-lb. capacity car, including

bility, it was given first consideration. Steel shapes either rolled or pressed were used throughout, and so arranged as to allow the minimum deflection in either direction. Special consideration was given the construction of the center sill, for which a Bethlehem H-section, weighing 84.5 lb. per ft., is used.

Horizontal buckling of this sill due to buffing is resisted by the entire underframe, which is a truss within itself, bringing into action the pressed steel diaphragms, channel section diagonals and Z-bar side sills, while vertical buckling is resisted by the side frame trusses, acting through the diaphragms. Pressed steel draft sills which take the pull only are attached indirectly to the center sill by means of a steel back-stop casting, and are fitted with the Sessions type K draft gear with the Farlow one-key draft attachments. The bolsters and diaphragms are made up of ¼-in. plates flanged

to fit the center and side sills and fitted with top and bottom cover plates. The side sills are 6-in., 15.7-lb. Z-bars.

The side sills also serve as the bottom chords of the side trusses, while the top chord is a 6-in. by 3½-in. by 5/16-in. angle. The side stakes and diagonals are of angle section, a very effective shape in that the neutral axis is nearer in line with the points of attachment than is the case with other rolled sections affording the same advantages for riveting and attaching the sheathing. A unique as well as a very substantial joint is used where these members are framed to the top chord or side plate. Twice as many rivets are needed at the lower ends of the same members where the old style joint of the same strength is used. This arrangement has been tested out using full size members loaded to four times the normal load without rupture of either joint.

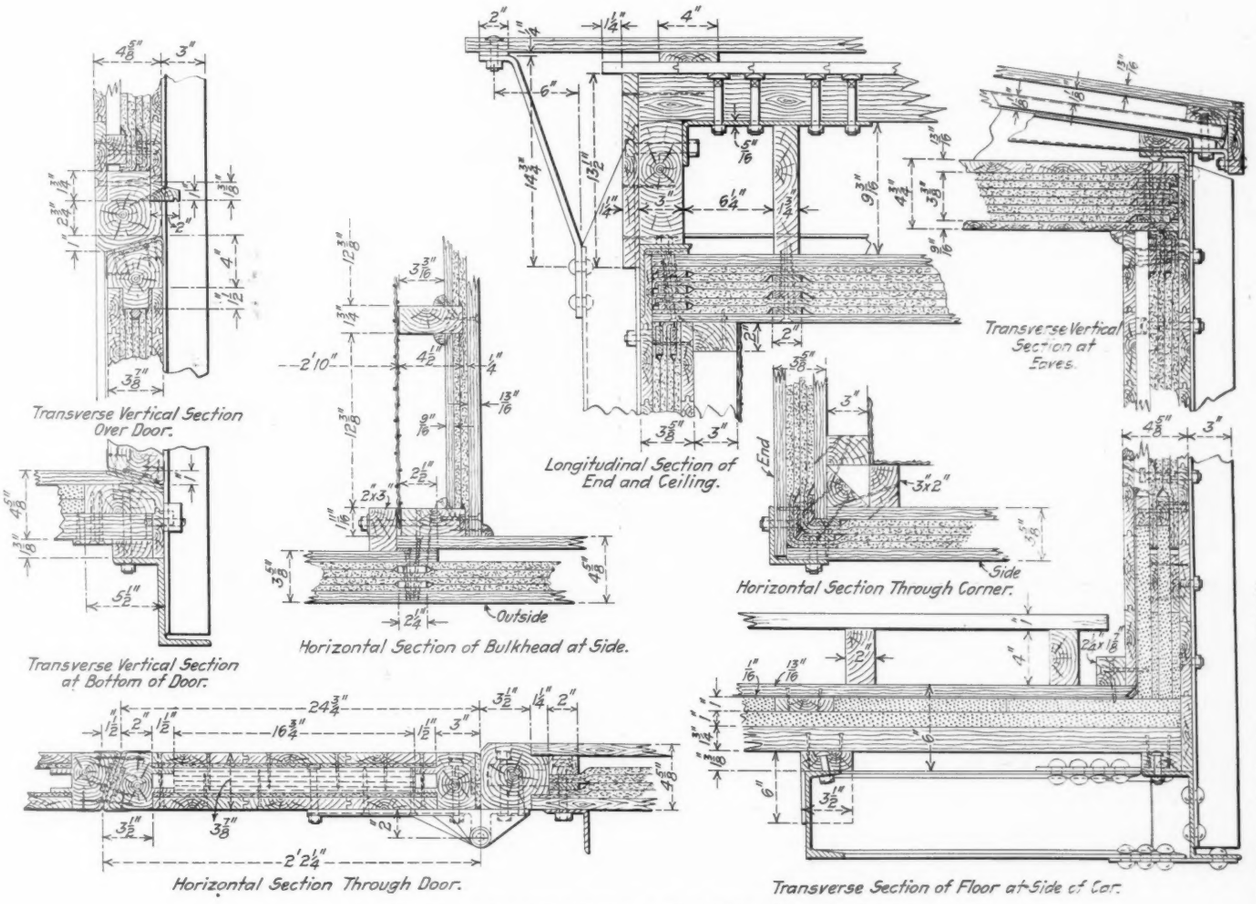
In the end panel of the side truss two flat tension members are employed, having a combined weight about equal to that of one stiff member ordinarily used, to provide sufficient side ladder clearance without putting the ladder so far away from the body of the car. One of these flat bars carries the overhanging end of the car, while the other comes into action when jacking under the corner of the car.

To still further increase the rigidity of the superstructure, the pressed steel carlines are secured at each end directly to the side truss by means of three ½-in. rivets. The car ends are well supported, each by two 4-in. Z-bars riveted to the draft sills and end sill at the bottom, to the end plate at the top and bolted to the ridge pole by means of a wrought iron knee. Again flat diagonals are used to give vertical support to the outer ends of the draft sills, and permit close placing of the end ladders.

The small metal clips shown riveted to the side plates are for attaching the roof. These afford excellent means of fastening, in that the roof, the Chicago-Cleveland improved Winslow inside metal roof design, can be renewed or repaired without disturbing any other part of the car.

INSULATION

The arrangement of framing adopted can be located advantageously entirely outside of the insulated walls, floor and ceiling. To keep the overall thickness of the side walls down to a reasonable figure, and at the same time provide a means of support that will hold the many layers of insulating material permanently in place, the insulating sheets have been bunched. While neither of these reasons for bunching and insulation applies particularly to the floor or ceiling, the simplicity of construction and the elimination of air currents between the successive layers, are sufficient to warrant the loss of any possible value of the so-called dead air spaces here. Therefore all insulating material is applied in a compact form with sufficient securing strips to fasten each layer rigidly in its place.

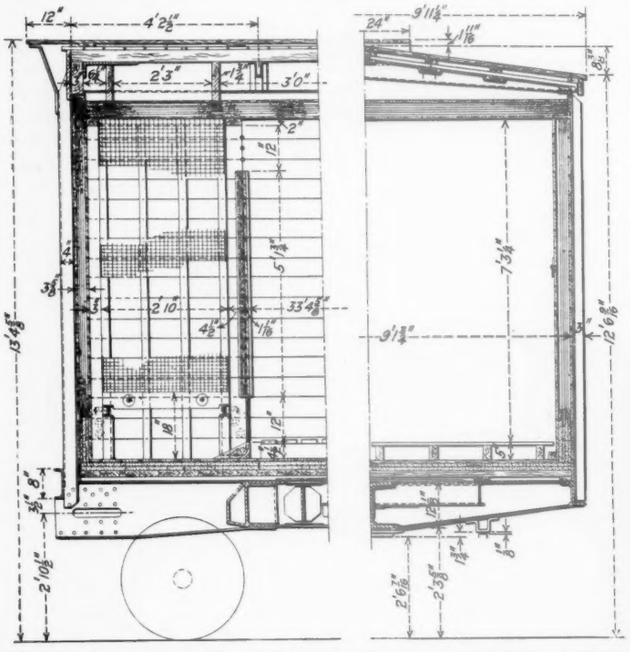

Transverse Vertical Section Over Door.
Transverse Vertical Section at Bottom of Door.
Horizontal Section of Bulkhead at Side.
Outside
Longitudinal Section of End and Ceiling.
End
Transverse Vertical Section at Eaves.
Side
Horizontal Section Through Corner.
Horizontal Section Through Door.
Transverse Section of Floor at Side of Car.

Details of the Insulation and Sheathing Construction

After the frame is riveted up, and the floor sills bolted in place, the 1¾-in. yellow pine sub-floor is nailed in place and serves as a platform while building the walls and ceiling. The outside sheathing of kiln dried, tongued and grooved 13/16-in. Douglas fir is next applied with grooves down and temporarily fastened to the steel frame with stub wood screws driven through holes in the steel framing from the outside. The false oak carlines are then bolted to the side plates, thus making the car ready for the ceiling.

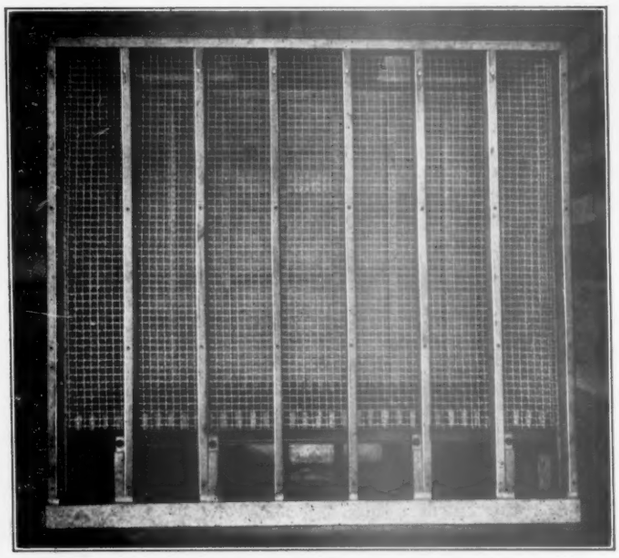
The insulated ceiling is composed of six continuous layers

of ½-in. hair felt between two fir ceilings, 13/16 in. thick above and 9/16 in. thick below; these extend lengthwise of the car for its full length and width, and are fastened to the oak carlines above with long wood screws. The weight of the ceiling is also supported by the side walls which are later



Longitudinal Section Through the Ice Bunker and Half Cross Section of the Car Body

built under its edges, an arrangement playing some part in maintaining a tight joint along the eaves. The securing strips for the different layers of hair felt alternate, first between the carlines and then directly under them. This method of support gives sufficient room for ½-in. strips by simply

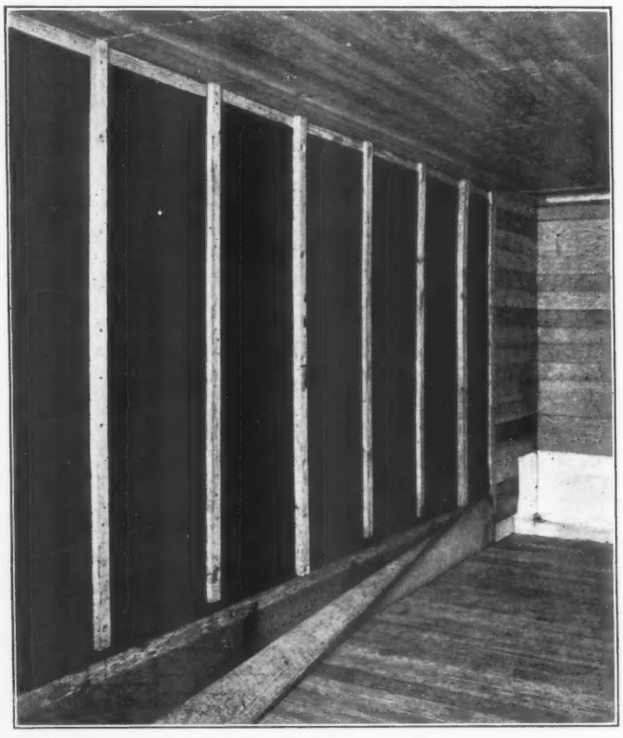


A View of the Ice Bunker Before the Application of the Bulkhead

compressing the hair felt at the strips, leaving it expanded to its normal thickness elsewhere. Each layer of insulation in the ceiling is in one piece, turned down around the edges and stripped. After the 9/16-in. lower ceiling is applied, long screws are driven through the ceiling into the oak carlines, while shorter screws, put in from the top, clamp the two wood ceilings at the intermediate strips. The latter screws, however, do not reach entirely through the lower wood ceiling.

The side walls are built in much the same way. The first layer of hair felt, reaching from the side door post around the end of the car to the door post on the opposite side, is unrolled in place and fastened to the siding with false nailing strips, placed vertically, two between adjacent side stakes. The second layer, exactly covering the first, is then put up and heavier strips placed directly opposite the side stakes are permanently bolted in place, using every second hole in the framing members. The temporary wood screws occupying these holes are removed as the bolts are inserted.

The third layer is applied like the first and the fourth like the second, except that nailing strips thick enough to hold the inside lining away from the insulation about one inch are located both at the side stakes and over intermediate nailing strips. This space is to prevent the waterproof paper



Interior of the Car Showing the Completed Side Wall Insulation and Method of Sealing the Joint at the Floor

covering of the insulation from becoming perforated by nails sometimes used by shippers to secure the lading in position.

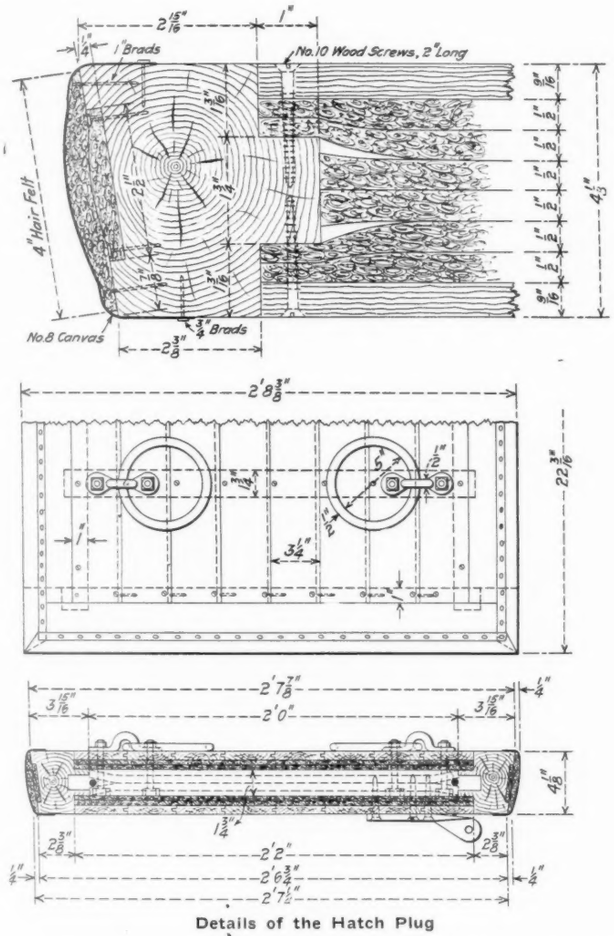
As the hair felt is quilted between two layers of waterproof paper this makes a total of two inches of hair felt and eight thicknesses of paper in the side and end walls while three inches of hair felt and thicknesses of paper, or 50 per cent more insulation is used in the ceiling.

The side insulation extends within 12 in. of the floor. From this line down the insulating material consists chiefly of cork, which is preferred on account of the possibility of water getting into the floor or lower portion of the walls, where it would render the hair felt practically worthless. However, every means has been provided to prevent such an occurrence. The first layer of 1 in. cork boards in the floor is continuous, having the joints between the pieces cemented together with a flexible asphalt applied hot, while 1-in. by 4-in. floor nailing strips are inserted and cemented into the second layer with the same material. The cork ex-

tending 12 in. up the walls is also set in hot asphalt thereby sealing the joint between the floor and sides. Over all of this and immediately under the top floor is placed a heavy but flexible asphalt-coated burlap plastic extending up the side and end walls above the cork and interlapping with the hair felt, which helps to waterproof the floor and still further seal the joint at the floor line. The top floor is of 13/16-in. yellow pine and floats on the cork.

The hatch plug although of ample size is light and effective, being practically all insulating material set in a substantial wood frame. Six layers of ½-in. hair felt are used in the body while the edges are fitted with two layers covered with a heavy canvas.

One feature not to be overlooked is the fact that there are no bolts, screws or nails used in any part of these cars passing through an insulated portion which have both ends



Details of the Hatch Plug

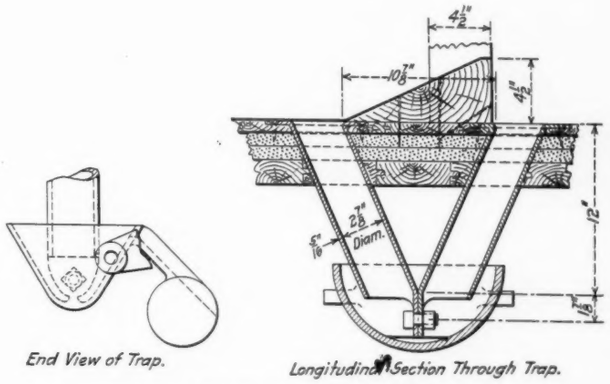
exposed. It is considered poor practice to employ insulating material, then pierce it with metal heat conductors. Leaky joints, especially along the edges of the floor and ceiling as well as around the hatch plug, door and door post have been guarded against, as may be seen in the illustrations.

The bulkhead, which is insulated with two layers of ½-in. hair felt, is framed of oak and secured to the floor and ceiling to resist shifting of the lading.

The ice bunker is the wire basket type with a 3-in. air space on all sides. This allows ample contact between the air and ice and gives an unrestricted passage for the circulating air. The ice grate is built up of oak bars bolted together. Three sections are provided for each bunker and they rest loosely on the grate bearers, rendering cleaning of the drip pans or renewing the grates an easy matter.

While most of these cars are being equipped with the usual type of floor racks made in eight sections five inches high throughout, others have been fitted up for comparison with a new design of rack which is lighter, more durable and has several other advantages. This rack is made in four sections and decreases from 5 in. high at the bulkheads to 1½ in. at the edge of the door. It forms a theoretically correct conduit, gradually diminishing in its cross-sectional area as the cold air is led off through the lading. To make it practical the rack is not carried out to the theoretical feather edge, but is cut off at the door post and a renewable wearing pad fixed to the floor between the doors. This eliminates the troublesome flexible end ordinarily used, permits trucking the lading through the cars and renders cleaning easy. It also has a tendency to resist shifting of the lading against the bulkheads. This construction serves to keep the cold air from flowing in a body to the center of the car, where it might pass up through a vertical vent left in load, with the result that the amount of heat absorbed would be less and the circulation retarded.

These plans were prepared under the direction of W. H. Lewis, superintendent motive power, and John A. Pilcher,



Drip Trap for the N. & W. Refrigerator Car

mechanical engineer, of the Norfolk & Western. Advantage was taken of the experiments conducted by the Food Research Laboratory of the Agricultural Department through the co-operation of Dr. M. E. Pennington, who has approved the design.

THE PACIFIC COAST PORTS are rapidly becoming the favorite route for merchandise bound to or departing from the United States, says a bulletin of the National City Bank of New York. The share which the Pacific ports handled of the import trade of the United States in the nine months ending with March, 1918, was 22 per cent against only 12 per cent in the corresponding months of 1917, while the share handled by the Atlantic coast ports was 56 per cent against 68 per cent in the corresponding months of 1917.

ENGLISH RAILWAY INVITES SUGGESTIONS.—The London & North-Western Railway has issued a notice in its Crewe works that the company will welcome suggestions for the improvement in methods of manufacture or carrying out work which occur to any of its staff, and in the event of any such suggestion being made use of by the company, and found beneficial, a suitable acknowledgment will be made, and, if desirable, assistance will be rendered towards the patenting of the same, under the usual conditions appertaining to patents taken out by employees of the London & North-Western. In conformity with the notice the directors have recently granted a reward of £5 ($25) to a man in Crewe works for suggesting an improvement to the machine on which he was engaged.—*The Engineer, London.*

FREIGHT BRAKE MAINTENANCE*

Properly Maintained Efficient Freight Brakes are Vital to a Solution of Present Transportation Problems

BY F. B. FARMER
Northwestern Representative, Westinghouse Air Brake Company, St. Paul Minn.

TO help win the war is the highest ambition of every loyal railroad man. All other interests are secondary and the best way to help is for all to co-operate in securing the safe and expeditious movement of trains. Passenger trains must be moved and promptly, but it is especially necessary that freight trains and locomotives be so maintained and operated that the maximum possible gross ton-mile capacity may be realized. As all train movements are absolutely dependent on efficient air brakes, the importance of proper freight brake maintenance will be readily appreciated. It is the purpose of the following article to show, first, that freight brake maintenance is generally unsatisfactory, second, why it is unsatisfactory, and third, how it may be improved.

PROOF OF UNSATISFACTORY CONDITIONS

Several years ago two representatives of the Westinghouse Air Brake Company and two railway air brake experts, after giving particular attention to freight train break-in-twos, became convinced that freight train brakes in interchange service were not being maintained as well as the needs and the time and money spent on them would warrant. In order to prove their contention beyond reasonable doubt, a "dead line" division point on a certain road was established at the top of a descending grade and freight train brakes were tested at this point with a 20-lb. continuous service reduction from 70 lb. It was required that all brakes must apply and remain applied during the 12 or 14 minutes needed to inspect the entire train and any car that would not stand this test was set out for repairs.

A 20-lb. continuous service reduction from 70 lb. should produce approximately 50 lb. pressure in the brake cylinder but brake pipe leakage causes more air to leak in from the auxiliary reservoir during the inspection and since five or six pounds will hold the brake cylinder piston in applied position the test requirement indicated above was very moderate. No test of the retaining valve was included and no air brake was considered ineffective unless entirely off when inspected. In spite of easy test requirements, however, 10 to 12 per cent of the cars inspected had to be set out for repairs. A particularly disturbing feature noted was the short time a large proportion of the defective brakes, as indicated by the stencils, had been put in good condition.

The seriousness of this condition is well illustrated by the following table, which shows the number of defective brakes on system cars during the month of July for 1913, 1914 and 1915, together with the percentage of brakes found defective after one, two, three, etc., months of service from the last cleaning date, as shown by the stencils:

Month of July for	Number of brakes recleaned	Percentage of system cars recleaned according to the number of months service from last cleaning date											
		1	2	3	4	5	6	7	8	9	10	11	12
1913....	596	21.3	35.7	44.7	51.9	56.9	63.0						
1914....	823	18.9	28.1	36.2	43.0	48.2	52.6	58.4	65.1	76.1	84.9	93.5	96.9
1915....	630	8.8	16.1	23.8	30.9	36.3	44.6	47.7	54.1	65.2	75.7	85.4	95.4

These brakes were repaired at the "dead line" point. A record of the system cleaned brakes only was taken, because it was desired to improve the work of the particular road referred to. While the table shows an improvement in condition, it also shows the possibilities remaining after two years of special and unusual work done to improve the condition of the brakes. The foreign cleaned brakes on this road showed a much worse condition. A check made in October and November, 1917, showed that of 1,103 system cars, 14.1 per cent had defective brakes, as compared with 25.3 per cent on 659 foreign cars. During 1914 the average time a car ran before being recleaned was 6.6 months. For 1915 this was increased 7.5 per cent to 7.1 months. It will be noted that in 1913, 44.7 per cent of the defective brakes were inefficient three months after cleaning, which was decreased to 23.8 per cent in 1915. This creditable showing was the result of establishing but one "dead line" and that operating in one direction only. Although a special effort was made in 1914 to improve conditions and encouraging results were obtained as shown in the table, a gage test for brake cylinder leakage made at various division terminals in 1915, showed that out of 164 freight brakes tested immediately after cleaning, 52 leaked down over five pounds in one minute.

The customary method of lubricating had been followed, which included filling the expander space next to the inside of the packing leather with lubricating grease. This temporarily stops or reduces leakage through a defective packing leather, and the unfavorable results stated were minimized. To demonstrate this fact, a special gage test was made of a packing leather that the average cleaner would judge by inspection to be good, but which in reality was very porous. With a dry surface on the expander side and a lubricated cylinder wall, it leaked 38 lb. from 50 lb. in one minute. This was reduced to seven pounds leakage by filling the expander space with lubricant. After being under a pressure of from 50 lb. down to about 30 lb. for 90 minutes, the leakage had increased from 50 lb. down to 37 lb. This showed that the lubricating grease on the porous part of the packing leather had been forced through.

Reverting to the gage tests, 12 brakes just cleaned leaked up over three pounds from 50 in one minute, due to faults in the triple valves or their gaskets and in this test a limit of three pounds leakage should certainly not be exceeded. From excessive cylinder leakage and other causes 40.6 per cent of the 64 brakes tested were found defective immediately after cleaning.

A gage test of 76 brakes that were selected at random in 1917 after having run three months from the date of cleaning, showed the following leakage from 50 lb. in one minute:

71 per cent leaked over 5 lb.
79.2 per cent leaked over 10 lb.
40.7 per cent leaked over 15 lb.
21 per cent leaked over 20 lb.

Regarding the present general condition of freight brakes in interchange service, terminal tests and inspections show that due to the establishment of "dead line" points, there is a noticeable improvement in air brake equipment, as compared with 1915. There is great need, however, for further improvement because of 2,276 cars recently examined, 14.1 per cent with inefficient brakes had to be set out for repairs.

CAUSES OF POOR BRAKE MAINTENANCE

The "dead line" data given above and recent tests show that freight brake maintenance is very unsatisfactory, and the explanation does not lie in the fact that cylinders and

*Abstract of a paper presented and discussed at the April meeting of the Canadian Railway Club.

valves are stenciled without being cleaned. With a view of locating the real trouble four experts worked with the brake cleaners for a period of six weeks, making gage and soap suds tests of a large number of brakes, including those just cleaned and others that had run for various periods. With each brake found to have over five pounds brake cylinder leakage per minute from an initial pressure of 50 lb. the fault was located and remedied, and the local brake cleaner thereby shown how to remedy the defect. Among these defects may be mentioned in the order of their estimated proportions, defective brake cylinder packing leathers due to being worn, cracked, cut, porous, off center and applied reversed, loose brake cylinder piston follower nuts, dry and dirty brake cylinders, expanders out of place or not fitted, release valve or "bleeder" leakage, pressure cylinder head gasket leakage, cylinder pipe leakage with detached equipment.

The last mentioned is usually due to no provision for reasonable flexibility in the pipe and to the cylinder moving when the brake is applied and released. On roads handling much of such equipment, this cause for defective brakes will be relatively much more important. In addition to the ineffective brakes due to the foregoing causes, as disclosed by terminal brake tests, there are others, resulting from bad order brake rigging, such as broken rods, broken brake hangers and beams, good order brakes received cut out and left so without test, and brakes with a piston travel over 10 in. (Federal rules designate such as ineffective brakes.) As regards brake beams, a recent tabulation on a mountain division of one road showed an average for a week, based on conductors' reports, of two beams down per day, the principle causes being hanger pins out, or hangers broken.

The brake cleaning and repairing faults indicated above are merely symptoms and the real underlying cause for unsatisfactory freight brake maintenance is superficial inspecting, testing and repairing. The lack of sufficient time for this work, or possibly the lack of an adequate force of inspectors, results in obtaining a quantity of work at the expense of quality. There is often a daily local pressure to have certain bad order cars repaired at a certain time when the repair track is to be cleared, and the result of this pressure is a slighting of the work. Daily pressure, understandingly applied, is necessary, but the almost entire absence of a balancing pressure and provision for good work, together with the lack of sufficiently competent workmen and needed tools or materials will inevitably result in superficial repairing.

It has been shown that with good initial brake installation and efficient cleaning and lubricating, freight brakes will, as a rule, be reasonably efficient for from nine to 12 months. The results with many brakes apparently support this contention.

It is not only poor economy to allow insufficient time for brake repairs, but to try and use material that is worn out or otherwise defective. In one case under investigation, it was determined that excessive brake cylinder leakage was due to a badly worn and cracked packing leather. Upon questioning, the workman stated that he was aware of the condition of the leather, but had been reprimanded for using too many new leathers and thought he had "better take a chance on that one."

There is generally more reason to criticise undue retention of defective packing leathers, gaskets and rubber seats for emergency valves than of applying new unnecessarily. All such removed parts should be sent to a central point for inspection, so that any still suitable for use may be saved.

METHODS OF IMPROVING CONDITIONS

To improve conditions it is necessary first to secure more complete supervision of the work of repairing and maintaining freight brakes and in connection with that all employees must be educated to understand the importance and necessity of efficient brake equipment. This is especially necessary because the very large labor turnover in railway repair shops has resulted in the employment of a force of men new to the work and seldom properly instructed as to how it should be performed. The second recommendation is the establishment of as many "dead line" points as possible where incoming freight trains may be inspected and the bad order cars set out for repairs.

Outgoing freight brake tests should be used merely to check against error, because if a bad order car is not detected until ready to go out, the result of switching it to the repair track at that late date is to disorganize the despatching and switching, and cause a serious delay to outgoing trains. The better plan is to make a freight brake inspection of each train immediately on arrival at a "dead point" while it is under blue signals. Assuming that the proper brake application was made by the incoming enginemen, a thorough brake inspection can be given, minor repairs made and cars with inoperative brakes marked for repair tracks, all during the time and protection afforded by the general inspection. As the air brake inspection must be begun as soon as the brakes are applied and must be completed quickly (within 20 minutes), it cannot be performed by men making the general inspection.

Under the proposed plan, the yardmaster is informed before switching just what cars are ready to proceed. Thus, brake delays to departing trains are avoided, brakes are maintained and incident expense is kept at the minimum.

But these desirable ends all depend on the correct performance of a simple duty by the incoming crew. The engineman must leave the brakes entirely applied by a 20-lb. reduction, merely adding to any reduction needed for stopping, the amount necessary to total 20 lb. It is possible to have this made as one reduction and some enginemen do so by carefully making the stop with the engine brakes only, but the first method will have to answer in many cases to avoid the delay of releasing and recharging.

If less than a 20 lb. reduction is made, some brakes in condition to proceed will be found unapplied. On being sent to the repair track these will be found operative and the inspector may be criticised for the unnecessary work and delay. Thereafter he will fear to mark brakes found unapplied "bad order," especially if there are several in a train. Thus, there will be either useless expense and delay, or brake maintenance will depreciate with its resultant dangers and ultimate greater expenses, all due to an improperly made incoming brake test.

In the repairing of car brake equipment it is understood that triple valves cannot be well maintained unless at each periodical cleaning they are cared for in a suitable room, having among its facilities a standard test rack. It is decidedly necessary that triple valves be not only cleaned, but repaired and put in good order. The manufacturer's instruction book for use of the standard test rack, gives much of the information needed to care for triple valve repairs fairly well, but the men who maintain the rest of the brake equipment on the car have generally to depend upon verbal instructions. To aid such men, the Westinghouse Air Brake Company has had certain of its men who are closely in touch with such work, prepare instructions for the brake work to be done on the car.

In general short piston travel (less than 6 in.) and brake pipe leakage render good braking very difficult. A piston travel of 9 in. is actually less objectionable than one of 6 in. The former by giving a much less increase for ordinary braking reductions, lessens slack action and consequent shock, yet is almost as efficient in full application as a 6-in. travel. It will be of interest to know that recent tests on a number of freight cars, starting from 50 to 60 lb. in the brake cylinder, gradually reducing the pressure, and noting the amount remaining after each ¼-in. recession or loss in

piston travel, gave an average amount remaining of 30 lb. after ¼-in. recession, 20 lb. after ½ in., 10 lb. after ¾ in. and 5 lb. after 1 in. This test shows that 1-in. less in piston travel means a loss of all effective holding power.

The bad results from brake pipe leakage are much greater with long trains, and increase more rapidly than the train length; that is, a rate of leakage that would not be particularly detrimental with 40 cars, would prevent good handling with 80 cars. For the purpose of detecting brake pipe leaks, it is necessary to use the soap suds test. A loose pipe means a future leak, as also does a rigid pipe, where the need of some flexibility is plainly indicated. An example of this is given in the branch pipe connection from the main pipe to the triple valve.

One point that deserves attention is the waste of shoe metal and loss of brake efficiency resulting from brake shoes that overlap the wheel treads. This is due to the old head spacing of 60½ in. magnified by manufacturing errors and the spreading action of the overlapping shoes. In addition to insuring that all new beams have the 60-in. spacing, the errors should be rectified in repairing old beams.

Trains cannot be held down steep grades with the air brakes without the aid of retaining valves and no part of the air brake requires less to maintain it, if once properly installed; also no part usually gets less attention. The lack of attention given this part of the equipment is well illustrated by the case of one railroad, which had entirely neglected to provide a piece work price for the testing and repairing of retaining valves. The cost of repairing and maintaining retaining valves in good condition is not large and such repairs should not be neglected on account of underestimating the value of the valve.

In regard to stenciling, the Northwest Air Brake Club of St. Paul, Minn., has proposed to the Air Brake Association a revision of M. C. B. requirements regarding brake repairing and stenciling, as follows: It is submitted that the present M. C. B. stenciling for freight brake cleaning, etc., can be simplified, time and money saved, brake maintenance improved, and more use obtained from the cars by adopting a rule that when either the triple valves or the brake cylinder must be cleaned, all other parts, including the retaining valve, dirt collector, etc., shall be cared for at the same time; also that any other repairs needed by the brake equipment shall be made. The stenciling should show the shop numerals, date and initials of the road doing the work. This information should be placed on both sides of the reservoir.

DISCUSSION

An interesting and somewhat extended discussion followed the reading of the foregoing paper. C. H. Weaver of the New York Central raised the question as to whether there was any inherent weakness in design or improper initial installation of the apparatus that could account for the many defects found in air brake equipment and foundation brake gear. It was the belief of the speaker, and many specific instances were quoted, to show that because equipment was going on a freight car, it was not considered important or necessary to do particularly careful work. The result was that many minor defects were allowed to go into the work and an improper initial installation was obtained.

It was stated in the paper of the evening that 37 per cent of derailments on a certain road were caused by brake beams dropping down which showed that too much attention could not be given to the method of applying brake beams, and the chairman stated that the Canadian Government Railways for six months had been following the practice of connecting brakes, so that the connecting rod will pass between the upper and the tension member of the bolster, the lower part of the truck lever being connected to the brake beam. In this way the brake hanger pin can drop out and the beam will not fall to the track.

The Canadian Government Railways started two "dead" points and were surprised to find the large number of brakes that would not pass the inspectors. A special effort is made to clean the brakes and get them in good condition during the summer months, because under the severe weather conditions during winter months, it is impossible to get the work done properly. Attention was called to the serious hose trouble due to cold weather and the fact that air brake men in Canada devote 50 per cent of their time in the winter to stopping leaks in the air hose gaskets. In one instance it required 1½ hours on the Lake Superior division of the Canadian Pacific to get sufficient pliable hose and gaskets, so that the pump could maintain the maximum main line pressure. This trouble happened every time the train went into a siding between divisional points where the slack was bunched and stayed there over 15 minutes. When it started again and stretched out the slack in the train, the hose would leak in the gaskets.

L. H. Albers of the New York Central, stated that with proper maintenance on the road, less shop work would be required on freight cars and time would be saved in getting up train-line pressure in the yard, all of which will assist in getting trains over the road with a minimum delay. He also brought out the fact that there should be closer co-operation between the drafting room and the general air brake inspector and outside men. Very often cars are produced today with an entirely new design of brake gear, and the man in the field who looks after the brakes never even knows that these cars are coming until they arrive.

To show the importance of properly maintained brakes and the necessity of keeping all valves in good working order, P. J. Langan of the Delaware, Lackawanna & Western, cited two example. A car on a heavy freight train on a descending grade was derailed by a broken wheel due to blocked retainers and wheel heating. A four-engine train was coming up the grade and the derailed car caught and overturned the tenders of the two engines on lead, the pressure of the two engines in the rear buckling the train in four places. All of this damage was the result of retaining valves being blocked.

Another case would have been serious had it not been for the *good* condition of the brakes on the train. A heavy train descending a grade had ice accumulate inside the brake pipe. This was loosened and blocked the angle cock on the first car back of the engine. The engineer immediately called for assistance. At the time there was 75 lb. pressure on the air gage in the caboose and the conductor instead of using the conductor's valve in the caboose went out on the train to see what was the matter and did not think it necessary to open the valve. The train arrived at the bottom of the seven-mile grade without the least damage. The angle cock was freed from ice and the same train was taken down a grade twice as long without any work being done on the brakes, which showed that the brakes were in proper condition, whereas if they had been in bad shape there is no doubt but that a wreck would have happened that would have cost the Lackawanna $100,000, and perhaps the loss of life. Proper brake maintenance is a necessity and when an engineer handles a train with the knowledge that his brakes are in good condition, it produces contentment in that man's mind for the remainder of the trip.

In connection with the incoming brake tests, W. Clegg, of the Canadian Northern, pointed out that when the brakes leak off, it is often difficult to determine whether the leakage takes place by the brake piston or the check valve in the triple valve, or whether it is due to brake pipe leakage.

In his final remarks, Mr. Farmer recommended that nine months instead of twelve should be the stipulated time for considering a brake out of order and some way must be found to make the repairs quickly and get the cars back into service as soon as possible.

SHOP PRACTICE

"THE REAL TEST IS TO GET RESULTS"

BY HARVEY DE WITT WOLCOMB

Suffering cats! but the "big boss" was mad. He was so hot that he could neither see straight nor think; and the busy terminal at Gardner suffered in consequence. Not that every roundhouse foreman is not out of sorts about something nearly all the time, for a roundhouse job is a continual grind on a man's nerves. But this day Dan Caddahan, the general foreman at Gardner, was uglier than usual. He was particularly polite, for one thing—a sure indication that he was loaded to the muzzle with a charge of sarcasm that would get any man's goat, and the men, knowing fully what to expect, kept their distance. It didn't take long for that mysterious shop method of spreading important news to warn every workman and sub-foreman to "watch out for the big boss."

And it was such an insignificant thing that caused all the trouble—just a piece of ordinary window glass. But then, it's generally the small things that start trouble on a railroad.

About three months ago—before the cold weather set in—Dan had checked up his winter requirements for cab sash glass, and had written the storekeeper a special letter asking that the supply he mentioned be secured at once so that when the time came they would have no cause for complaints. Unfortunately, the supply did not arrive, and about ten days prior to this eventful day Dan had a "run-in" with one of the engineers, who made a kick over putting in two pieces of glass in his cab window instead of one. At that time Dan personally asked the storekeeper to wire headquarters to make passenger train shipment, as they were then cutting up two larger glasses to fit the standard cab sash. This resulted in a waste of both glass and time to apply; also, it left a seam up and down the sash, through which water and wind could blow in on the engineer. The engineers began to kick, but Dan soothed their anger by promising early relief, just as soon as a supply of the right size glass arrived. This morning he had received a personal letter from the superintendent wanting to know why engineers' reports were not attended to, citing several cases of cab sash glass to be applied, yet the engineers reported no relief.

As Dan read this letter he went right up in the air and, started for the storekeeper's office, letter in hand.

Striding into the storekeeper's office, he angrily asked that worthy official to read the letter and then advise when he could expect a shipment of glass. The storekeeper hastily spoke up that he did not know what the present status was, but would secure the file. He was under the impression they had been "punching" the delivery of glass every other day.

"Oh, yes," replied Dan, "that is the usual case. You fellows don't seem to worry about getting material; you simply mark a letter 'punch every day or so,' and then that letter is handled with regular machine-like precision. What I want is *glass,* not 'punchers' or files. If you can't get any glass from headquarters, why don't you go uptown and buy some? Do anything to help out the situation, for both the superintendent and I have troubles enough without any additional kicks from the engineers."

"That wouldn't do," said the storekeeper, "without first securing permission to make local purchase; and that would take at least two or three days to secure."

"Well, then, I suppose it is up to me to tie up a first-class locomotive," angrily replied Dan, "just because you are afraid to take a step to keep the road running. What are you here for, anyway! To follow orders and tie up power, or to use a little common sense and break a rule? Now, what shall I do?"

"Can't you find some other way out?" asked the storekeeper.

"That's it," answered Dan, "just another glaring example of why it is costing us so much to keep the old road going. Sure, I can build new sash for every locomotive, which will cost about fifteen times as much as glass will cost, and then as soon as I get the new sash made you will run out of the present size glass and I will have to alter the sash to suit. That is the way I am working all the time; rebuilding or making over just to suit the stock you happen to have."

"I am very sorry indeed," replied the storekeeper, "but my hands are tied and I cannot do any more than I am doing."

"Is that so?" said Dan. "Let me show you how a roundhouse foreman handles a situation like that. Why, man alive, if one of my foremen didn't have more backbone than any three men like you, I'd fire him on the spot. What you ought to do is to get the glass, for you know we need it. You are in a rut, and I am going to show you how to get supplies."

Turning on his heel, Dan left the office and went over to the despatcher's office, for he wanted to send some telegrams. The first one he sent to the purchasing agent as follows: "Power tied up for glass, size twenty-six by thirty inches." Writing out another message, he told the operator to send the second one right after dinner. The second message read, "Glass not received. Am making local purchase to relieve situation. Rush regular supply passenger train." To both these messages, Dan signed the storekeeper's name, for he knew he was in deep water anyway, and if there was any trouble about his actions he might as well get fired for a big offense as for a small one.

Leaving the despatcher's office, he sent one of the call boys up town to a hardware store for six glass of the size he needed, telling the boy to have the hardware company send him the bill. As other things demanded his attention, Dan dismissed this matter with a grin, as he thought of what would happen when the fireworks went off.

Long before noon Dan saw his carpenter going through the house with a big pane of glass under his arm, so he knew that temporary relief had been secured, anyway.

About four o'clock in the afternoon the storekeeper came down through the house with a telegram in his hand. Looking for Dan, he found that worthy official in an ash pan, and had to wait a few minutes before he could get near enough to show him the message.

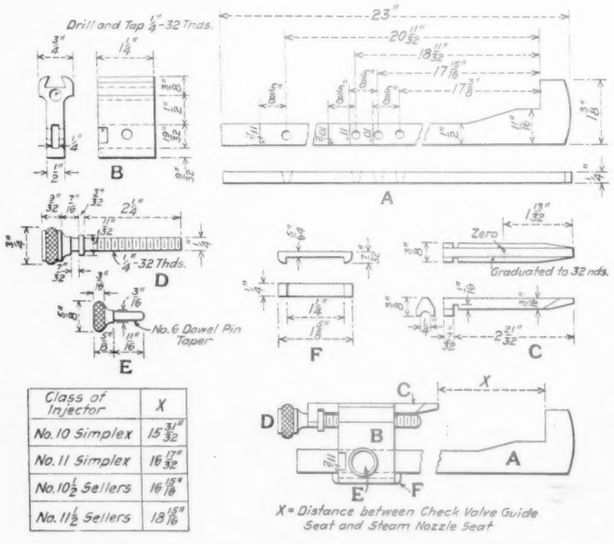
"Do you know," said the storekeeper, "I have secured word from the purchasing agent that glass will be here on the night express, but I don't quite understand what he means in the last part of his message, where he says, 'O. K. to purchase'."

Grinning all over, Dan turned to the storekeeper and said, "Let me tell you something. The real test of a successful roundhouse foreman is to get results. That same test applies to a storekeeper as well, only in your case it is to get material. This morning, when you couldn't get me any glass I helped myself, so just pin that message to this little bill and put it through in the regular manner."

INJECTOR GAGE

BY E. F. GLASS

In repairing the Simplex and the Sellers injectors, it has been found that the repeated facing of the steam nozzle seat allows the nozzle to enter too far into the combining tube, thus reducing the area around the nozzle and diminishing the efficiency of the injector. In order to overcome this



Class of Injector	X
No. 10 Simplex	15 31/32"
No. 11 Simplex	16 17/32"
No. 10½ Sellers	16 19/32"
No. 11½ Sellers	18 15/16"

Gage for Maintaining the Correct Relation Between Injector Steam Nozzle and Combining Tube

defect, the idea was conceived to insert a brass collar between the steam nozzle and seat, the collar being bored out large enough to slip over the thread on the steam nozzle. The outside diameter of the collar is ¼ in. larger and the thickness usually varies from 1/32 in. to 1/8 in. The gage illustrated was designed to determine the thickness of liner required.

Referring to the illustration, the gage consists of an adjustable jaw *A*, bracket *B*, slider *C*, adjusting screw *D*, dowel pins *E* and filling piece *F*. The distance *X* between the jaw and the slider is constant for each class of injectors and by moving the bracket *B* so that the dowel pins will fit in the four tapered holes indicated, it is possible to use the gage with the four different types and sizes of injectors shown in the inserted table.

The position of the taper pin is adjusted so that with the slider in a central position the distance *X* becomes standard in each case. The slider is marked to show the central position and graduations to 1/32 in. will readily indicate the amount of movement.

After the lever, steam bonnet, steam nozzle, combining nozzle, delivery nozzle and all other removable parts have been taken out the gage is inserted in the body of the injector, the jaw end being held tight against the check valve guide seat near the delivery end of the injector, while the adjusting screw is turned until the point of the slider bears against the steam nozzle seat, which has been faced. The distance between the zero mark on the gage and the one on the slider will determine the proper thickness of the liner required.

This gage is inexpensive to make and its use keeps the distance between the check valve guide seat and the steam nozzle seat constant and at the required distance to insure uniform and efficient injector operation.

A TRAVELING ANTI-WASTE EXHIBIT

In a large manufacturing plant where thousands are employed, it is surprising to learn of the food products and manufacturing material wasted each day.

To give the employees of the Westinghouse Electric & Manufacturing Company some idea of the waste, the management devised the novel scheme of fitting up a storage battery truck as a traveling exhibit, upon it a collection of food wasted including bread, butter, meat, cakes, crackers, pickles, cheese, fruits, etc., as well as a quantity of manufacturing materials such as copper, zinc, lead, mica, rubber, felt, gum and similar materials much of which could be used to advantage.

It is estimated that the food stuffs wasted per day would amount to between $35 and $50, the cost of which, of course, comes out of the employees' pockets; the waste of material amounting to hundreds of dollars per day, which would be a loss to the company if it were not that a force of men are continually assorting the seemingly scrap material and turning it back for use or so that the highest price may be obtained for scrap produce, all due largely to the thoughtlessness and carelessness of the employees.

Above the material is constructed a sign, reading in large letters: "Wasted" and underneath the words "Food brought

A Waste Exhibit to Excite Thrift

from your homes," and on the other side "Materials belonging to the company."

This truck was driven up and down the shop aisles so that the employees could look upon it and form in their minds some idea of the waste. Such an object lesson is valuable at this time when everyone should take all the precautions necessary to cause anywhere as little waste as is absolutely possible.

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July, 1918

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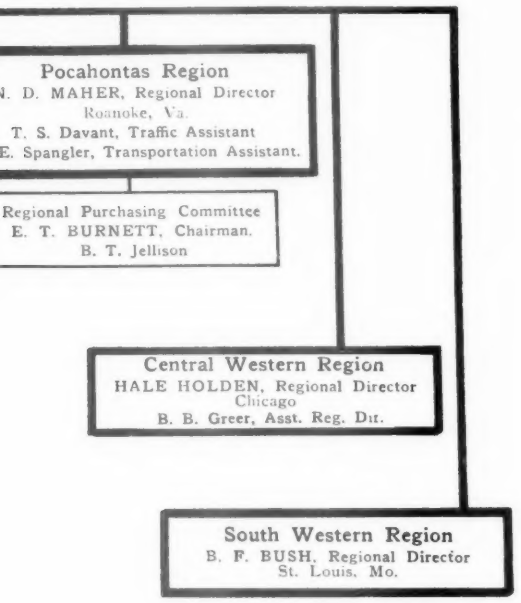
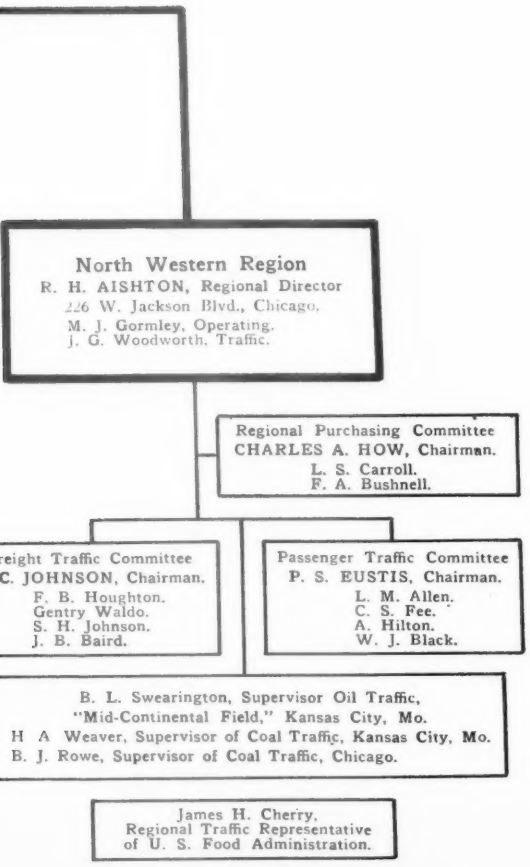




Regional Limits

Eastern Region

All railroads north of the Ohio and Potomac rivers and east of Lake Michigan and the Indiana-Illinois state line; also those railroads in Illinois extending into that state from points east of the Indiana-Illinois line, but excluding those roads included in the Allegheny and Central Western Regional Districts.

Allegheny Region

Pennsylvania Railroad (east of Pittsburgh and Erie).
Baltimore & Ohio (east of Pittsburgh and the Ohio river).
Bessemer & Lake Erie.
Cumberland Valley.
Central Railroad of New Jersey.
Coal & Coke.
Philadelphia & Reading.
Western Maryland.
Cumberland & Pennsylvania.
Pittsburgh & Lake Erie.

Pocahontas Region

Chesapeake & Ohio (east of Louisville, Ky., Columbus and Cincinnati, O., including the Chesapeake & Ohio Northern).
Norfolk & Western.
Virginian.

Southern Region

All railroads south of the Ohio and Potomac rivers and east of the Mississippi river, also those railroads in Illinois and Indiana, extending into those states from points south of the Ohio river and not included in the Pocahontas and Central Western regional districts.

Northwestern Region

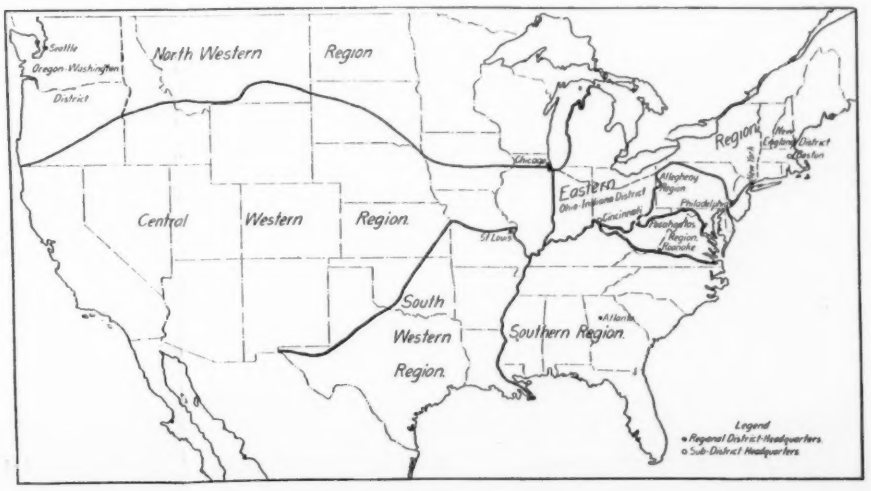
Chicago & Northwestern.
Chicago, St. Paul, Minneapolis & Omaha.
Chicago Great Western.
Chicago, Milwaukee & St. Paul.
Great Northern.
Minneapolis & St. Louis.
Minneapolis, St. Paul & Sault Ste. Marie.
Northern Pacific.
Oregon-Washington Railroad & Navigation.
Southern Pacific Lines (north of Ashland, Ore.).
Spokane, Portland & Seattle.
Spokane International.

Central Western Region

Atchison, Topeka & Santa Fe.
Chicago, Rock Island & Pacific (except from St. Louis to Kansas City; lines east of El Reno; lines El Reno to Memphis and branches, and south of Chickasha).
Chicago, Peoria & St. Louis.
Chicago & Alton.
Chicago & Eastern Illinois.
Chicago, Terre Haute & Southeastern.
Chicago, Burlington & Quincy.
Colorado & Southern.
Denver & Rio Grande.
El Paso & Southwestern.
Illinois Central (north of Cairo and Paducah).
Los Angeles & Salt Lake.
Northwestern Pacific.
Oregon Short Line.
Quincy, Omaha & Kansas City.
Southern Pacific Lines (west of El Paso and Ogden, except north of Ashland, Ore.).
St. Joseph & Grand Island.
Union Pacific.
Western Pacific.

Southwestern Region

Fort Worth & Denver City.
Fort Worth & Rio Grande.
Gulf, Colorado & Santa Fe.
Gulf Coast Lines.
Galveston, Harrisburg & San Antonio.
Houston & Texas Central.
Houston, East & West Texas.
International & Great Northern.
Kansas City Southern.
Louisiana & Arkansas.
Louisiana Railway & Navigation.
Louisiana Western.
Midland Valley.
Missouri Pacific System.
Missouri, Kansas & Texas.
Morgan's Louisiana & Texas Railroad & Steamship.
Rock Island Lines (south of Chickasha; El Reno to Memphis and branches; and St. Louis to Kansas City).
St. Louis-San Francisco.
St. Louis Southwestern.
San Antonio & Aransas Pass.
Texas & Pacific.
Texas & New Orleans.
Wabash Railroad (St. Louis to Kansas City and Omaha).
Wichita Falls & Northwestern.
Texas Midland.
Wichita Valley.



PIECE WORK SYSTEM IN RAILWAY SHOPS

A Discussion of the Organization of the Methods for Determining Proper Prices and of the Forms Used

BY W. J. McCLENNAN
General Piece Work Inspector, Car Department, New York Central, West Albany, N. Y.

THE principal object of this paper is to contribute in some small measure to the solution of those problems confronting production supervisors or piecework inspectors of railroad repair shops in these strenuous days when patriotism and necessity impel them to achieve maximum results. It is hoped that these remarks may draw out that discussion which, like a postscript, is generally the most valuable part of any communication. Railroads everywhere are beginning to select successful piecework inspectors or production men for the jobs higher up, and if this paper incites an occasional inspector to increased effort that he may prepare himself the sooner for advancement, the writing will not have been in vain.

CHANGE FROM DAY WORK TO PIECE WORK

It is especially important at this time that every shop should embrace the fairest and most efficient system of remunerating their employees for services performed. Under piecework the highest wage is paid, but a maximum output is demanded in return. In spite of the fact that there is probably no other industry extant where it is so difficult to inaugurate the piecework system as in the modern railroad shop, with its thirty or more trades and its multiplicity of problems presented by the varying damage to the many classes of equipment, the writer contends that the piecework system is unquestionably the most practical and holds that under proper management it can be substituted for the per diem system. To some, the latter statement will sound presumptuous and they can quote instances where certain working forces objected strenuously and even instigated strikes when the change was inaugurated; but, after investigation of such instances, the methods followed by those in charge were in most cases found to be questionable; bankruptcy prices had been erroneously granted to the men and then reduced, the change to a piecework system was tried on a wholesale basis, which meant that those who through stubbornness or other motives were unwilling to give it a trial were pressed into the experiment for the purpose of making a showing initially, instead of confining the plan at first to the isolated minority who are always willing to better themselves and who know on which side their bread is buttered. The splendid patriotism manifested by the working classes since war was declared should indicate to anyone that they will accept piecework now if it will help their country to win the war.

Records will show that the majority of mechanical forces in railroad shops today are working on a piecework basis which, in itself, is sufficient evidence that others can do it. It is also a fact that 99 per cent of all piecework employees complain bitterly if they are asked to perform a job on daywork basis. Very few cases will be found where employees of "open" or union shops will object to any system which allows them to increase their earning power from 25 to 75 per cent, if a fair minded management points out that it can be accomplished by performing their work more scientifically.

OUTPUT AND WAGE INCREASES ACCOMPLISHED BY ADOPTION OF PIECEWORK

The adoption of the piecework system will decrease operating costs or increase the unit output from 30 to 100 per cent without increasing the capital tied up in the plant, depending always on the degree of efficiency existing under the per diem system and the skill of those who install the piece work system. During the present man shortage the safety of our nation demands that steps be taken to increase the capacity of 100 men to 130, 140 and even 200. That this can be obtained is well known to those who have made the change from the per diem to the piece work system. Another advantage will be the increased wages accruing to those men who augment their output.

Such wage increases are stimulating while the novelty remains, and higher wages have their lasting effects also. Improved home life, constantly growing through modest bank account, with its attendant sense of satisfaction if not security, more extensive schooling for the children; these and many other advantages tend to raise the morale of the workman whose compensation is increased. The effect of the satisfaction to the men and the upbuilding of their character arising from the fact that their own increased efforts were responsible for these benefits can not be over-estimated.

For the corporation, there is an increase in the service rendered per man employed and a satisfied skilled force operating the plant instead of inexperienced floaters who improve their usefulness, if at all, at the employers' expense and make mistakes which cause waste of time, material and tools. No class of people live on a closer margin than the daily wage earner and they are quick to discern the diminishing purchasing power of the dollar. That corporation is not only fair but wise, which meets its men with a wage bonus during those periods when, through influences over which the operator has no control, the wage increase for which he has bent his utmost effort is offset by rapidly rising prices for the necessities of life. Under such conditions the piece work system of compensation will be found to possess great flexibility and the corporation has the satisfaction of knowing that any bonus allowed on piece work schedules is paid to a class of men who are producing maximum results.

OTHER ADVANTAGES OF PIECE WORK SYSTEM

The per diem system allows of no time limit being placed on output, in fact such efforts would be little short of bulldozing. The men are paid by the day and is it not perfectly human that they should be suspicious of any attempt to expedite output under a system of compensation which allows no reward for increased effort? The task of curbing the practice of spending excessive time on operations performed under the day work system is a distasteful if not an impossible one, and knowing the problems confronting workers in large railroad shops, it is far from the writer to throw stones at men who refuse to give something for nothing. Furthermore, under the day work system, a comparison of the output per man is impossible, and a cost system is out of the question, especially in assembly shops.

On the other hand piece work, properly regulated and inspected, insures good workmanship, maximum output, a wage scale based upon merit (not seniority or influence), minimum unit costs, standard practice and a perfect cost and estimating system. Freight and passenger maintenance and appraisal schedules would be impossible without piece work. It reduces the number of employees and therefore the pension and claim department costs. It places the control of the

wage earning power of the workmen right where it belongs, at the shop where the work is done. Of more importance than all these are the psychological advantages of the piece work system. It will automatically increase the satisfaction and hopefulness and therefore the health of the men, for an efficient piece work system anticipates diminishing the hours and even the fatigue of work.

PIECE WORK ORGANIZATION

The usual organization consists of one or more auditors or piece work inspectors in each department where the work justifies. These men report to their foremen and indirectly to a general piece work inspector, whose value to the company depends upon his executive ability, general knowledge and experience. Judging from observations made by the writer during a tour of practically every large railroad shop of the United States and Canada, the results obtained with this organization are satisfactory, considering the nature of the business.

SELECTION OF PIECE WORK INSPECTORS

A piece work inspector or production supervisor is selected not because he has worked at the given trade or one branch of it for a number of years, but, in spite of previous training, from that class of young men who possess the knack of distinguishing between action and progress, between load and capacity, between strenuousness and efficiency. If this qualification is supplemented by some practical shop experience I would almost say such a man is indispensable.

It is an error to select a man merely because he has spent years at the trade in question, sometimes at the expense of proper mental development and technical training, and very often to the neglect of that experience and association which would develop leadership, had he the potentiality. Irrespective of whether his knowledge were gained from books, schools, observation or factory experience, the production supervisor must know, or have the brain capacity to quickly learn, the art of correcting inefficiency. For instance, the machine shop production man must be able to detect the operator who is running his machine at less than the possible speed, feed and cut.

The profession of production engineering is one which, in the opinion of the writer, should command the attention and co-operation of all railway managements to the end that courses in instruction be provided for those of their employees who possesss possibilities along this line. The result would more than justify the means.

QUALIFICATIONS OF THE PIECE WORK INSPECTOR

A shop inspector is only a novice until he is capable of efficiently superintending the mechanical operations of his department to their proper, economical and expeditious completion, and until he is possessed of sufficient training and resourcefulness to collect and arrange the facts and formulate the laws relevant to such operations. It is needless to add that he should be intelligent, tactful, energetic, resourceful, honest, and unresponsive to the influences of the unscrupulous. The managements of a few roads have recently realized that his salary and title should be such as to differentiate him from the direct labor forces, and it follows that the prestige thus accorded him will tend to make the operatives accept his conclusions more quickly. Neither should the shop piece work inspector be compelled to perform all his duties without frequent aid from the general piece work inspector, especially in the establishment of prices representative of large classes of work.

PRICE FIXING—CO-OPERATION OF FOREMEN

It is not considered wise to deprive foremen of certain rights in connection with the establishment of piece work prices in his shop. As a general rule the foreman's experience and loyalty enable him to give advice of the most valuable kind and the successful inspector seeks it often. On the other hand the foreman knows that he cannot devote the time to the subject which is essential if accurate decisions are to be made. Furthermore he realizes that he has no right to set himself up as the supreme and final authority in his department. The shop superintendent has rights and so has his general piece work inspector to whom all prices are submitted by shop inspectors. As in everything else, the co-operation of all concerned will produce the best results.

DUTIES OF SHOP PIECE WORK INSPECTORS

Every workman realizes that the eight or nine hour working day permits his working to full capacity during that time. He also knows that a machine should be operated to full capacity if it would represent a good investment for his employers. It is the paramount duty of piece work inspectors to determine the full capacity of the workmen and machinery and to evolve a system of keeping them at full capacity, for he will find that most workmen complain bitterly when, through interruptions or inefficiency of the management, they are prevented from earning their maximum rate per day. The maximum capacity of workmen and machinery is determined by a detailed study of performances.

OPERATION STUDIES

It is this part of the inspector's work which demands the active assistance and moral support of the general piece work inspector, as it is sometimes found that in setting prices influences from several quarters are exerted against the inspector. The operation study made by a competent inspector not only will show the possibilities of securing greater efforts from the workman, but should include a frank criticism of former methods, machine speeds, machine and hand tools used, material delivery, routing of work, etc. *It should also contain an outline of the best conditions and most approved methods he is able to determine for the performance of the job in future.* It is not always possible to do this without incurring the displeasure of the workmen and foremen, no matter how tactful the inspector may be, but the reward of perseverance, honesty and tactfulness in this regard is a saving in time, economy in operations and expedition of the work.

In timing a given operation, consideration should be given to the following factors, which are listed in the order of their importance:

1.—*Safety features, cleanliness, lighting effects.*

2.—*Availability of material.* Insure uninterrupted deliveries.

3.—*Condition of material.* For example:—If metal is being machined, be certain that it has not been subjected to precipitous cooling in the forging shop, or machining time and tools will be wasted.

4.—*Machine, tool or jig.*—Select proper type. Drilling holes 2 in. in diameter on a drill press designed for ½-in. work is ridiculous and costly. Follow the latest approved data on machine speeds and feeds, angle of cutting tools and edges, heating treatment of tools, etc. If forging machine or bulldozer and furnace are involved, ascertain the time taken in heating and forging the article, also determine the forced inaction of the workmen between heats. If the furnace is loaded to full capacity and the record shows that unavoidable inaction of the men between heats is excessive, the need of a larger furnace is indicated.

5.—*Location of machinery.* This should be such that the work will pass through the machine shop without reverse movements or back travel.

6.—*Number of men used.* This depends entirely upon the circumstances. If the need for expeditious output is urgent, the working force must be larger (and the piece work price often greater) than would be necessary if the need for urgent deliveries did not exist. The statement that under ordinary conditions the men employed when studying an oper-

tion and performing the work thereafter should be the minimum number necessary to safely do the work, requires no elucidation.

7.—*Capacity of a workman.* A knowledge of this phase of the operation study can only be attained by diligent study. On all machine work the capacity of the workman is predetermined by the rating of the machine. These ratings, together with the correlated data obtainable as a result of exhaustive tests and calculations, enable an efficient piece work inspector to correctly establish the maximum amount of work which his men should produce when operating various machines. Some of this data, it is hoped, will be published later with the thought that it may encourage the beginners among railway shop inspectors to make further investigation of maximum machine output at minimum cost.

The capacity of an operator on bench work or material handling and assembling requiring manual labor exclusively, is quite another subject, and no set of rules can be promulgated for the guidance of the piece work inspector. Suffice it to say that he should see that constrained positions are always avoided. Lively movement may be demanded on light bench work, material deliveries and ordinary assembling or where cranes perform all the heavy work, but avodied on all heavy manual work.

In all cases of doubt the inspector should study the movements repeatedly until any unconscious or wilful slacking is brought to light. He should be able to settle upon a reasonable allowance for pauses and intervals of rest. (Appendix No. 1 illustrates the detail of timing records recommended by the writer.)

A determination of the capacity of the operator is the stumbling block of most inspectors, as some workmen, deliberately or through clumsiness, consume more time than is necessary on the operation. The inspector must ascertain, not the time consumed, but what should be consumed. There are many ways of determining the minimum time when an unfair operator is blocking your efforts. Often the job can be done by the inspector or gang foreman, by far the best method but often impossible on account of pressure of other work. It can be performed in other shops of the company and comparisons drawn. The time can be calculated by the "key" system explained hereafter. Or the job as performed by any operator can be so detailed as to show at a glance where the excessive consumption of time existed, as an experienced time study man soon learns the knack of properly judging the correct speed. The test can be made simultaneously by various men in the same shop thus trusting to the sense of competition which will be found among all men.

Only the most efficient operators should be timed and then only when exerting their best efforts. It is easy to make the proper allowances for the average men and set rates accordingly. When possible the work should be routed so that one gang's output and wages depend on the prompt and efficient action of the preceding gang.

If the inspector is honorable he will find that practically all of the men will meet him on the same basis. Exceptional ability and service should be rewarded by exceptional compensation. Allowance should be made for necessary interruptions in the work, and if the inspector timing an operation has not the creative instinct to recognize the need for and the ability to design suitable jigs to expedite the work before the piece work price is scheduled, he should not attempt to reduce a price on work for which a workman has devised a jig in order that he may increase his earnings. An inspector should be considerate enough to admit that no price should be based on the assumption that a workman should remain in a standing position all day if the work can be done while seated.

8.—*Rates used in setting prices.*—This angle of the operation study is simple and entirely in the hands of the local management. As stated above, when a piece work price is based on the operation study of a workman possessing exceptional ability and performing at exceptional speed, the rate allowed should be exceptionally high. Proper consideration should be given to the frequency of the demands for the work in question and the number required.

9.—*Collection and arrangement of facts.*—During the operation study the efficient inspector will determine the best method of doing the work and direct the operator accordingly. With the determination of the proper time the piece work price is obtained by multiplying this time by a rate commensurate with the nature of the work and the ability of the workman. This should be graduated, if necessary, to allow a higher unit cost when one article is made at a time than would be allowed if 25 or more are made.

THE KEY PAYMENT SYSTEM

Prices for standard and recurring work in fabricating shops are of course based on the piece, pound, foot, cubic inch, etc., and the economy resulting from the price schedules is predicated on the character and efficiency of the machines on which the work is done, admitting the ability of the inspector and the operator. Such prices are handled similarly on all roads and need no attention in this article.

There are many difficulties, however, in working unusual and non-recurring jobs on the piece work basis and the writer has found that they can be overcome by the use of a "key" or scale prices. The use of this key obviates the necessity of compelling workmen to do such jobs at his hourly day work rate and at the same time avoids choking the price schedules with operations which may never be performed again. On a band saw, for example, a key price of $.008 could be paid for each miscellaneous piece not otherwise specified in the schedule, and a scale of prices ranging somewhat as follows could be allowed:

Saw, cut-off, No. 25, cut off all lumber with cross sectional area of 27 sq. in or more, per cut made as recorded on indicator	$0.007
Poards, not otherwise specified any length, cut to length, fitted and nailed in position, ripping excluded, each	.01
Dove-tailing, including laying out and fitting, by hand, per pin and tail	.08
Dressing and sanding new mahogany or oak, per square foot	.028
Gaining all classes of lumber by hand, per cubic inch	.0025
Joint, cut by hand, per square inch of joint cut	.003
Molding, all classes, renewed, including dressing, per lineal foot, per inch in width	.003
Patches, made and applied, including gaining, fitting and gluing, per patch under 50 sq. in	.025
Bolts, nuts, screws, holes, plugs, sawing, etc., in addition.	

In this way almost any operation can be priced out, without timing unusual jobs and burdening the schedule with a specific reference to them. All unusual work required to be done on machines or by hand in blacksmith and machine shops is compensated in much the same manner. Miscellaneous prices are set up for heating iron and steel of limited sectional areas and the heating prices include necessary bending, plugging or cutting while hot. Higher prices are allowed for heats necessary to perform welds. Scrap axles and other material are drawn out to required size at $.40 to .50 per cut.

Key prices should be established on planers, shapers and slotters for removing a cubic inch of material, also setting up and removing work of given weights.

The same key price system is used with great success in all our big assembling shops. For example certain motors and wiring is installed in various shops, involving excavation, overhead and ground conduit and wire installations. Regardless of various locations, machine types, conditions, etc., attending each job, the entire operation is paid on basis of cubic yards of excavation, feetage of conduit and wires, connections, outlets, switches, etc.

The same principle is applied whether the job in hand is running air or steam lines, building a private car or locomotive cab.

MISCELLANEOUS

All wood-working machines except band saws and a few others should be provided with meters or counters for com-

puting the amount of work performed daily. They act as positive checks on the output when properly applied and save considerable supervision. The method of installing them to prevent manipulation is interesting.

Price descriptions in fabricating shops embody the name of the machine, shop identification number, operation, machine speed and unit, as for example:

Sticker, Berlin, No. 89, operating speed 84 f. p. m., running through all material not otherwise specified, per 1,000 lineal feet, $.10.

All piece work prices on repairs should contemplate a higher payment for replacing reclaimed material than would be allowed for applying new parts. There is no better way of securing material economy than paying workmen this extra amount as they have more control over it than the foremen or others.

Every step should be taken to have replacement parts for freight cars on hand before the defective parts in kind are removed from the car. This would often save one or two days on release of much needed equipment.

All shop cleaning in wood mills is paid on basis of total lumber feetage delivered into shops semi-monthly. It averages about $.39 per 1,000 f. b. m. Shop cleaning and delivering in all repair shops and yards is paid on a percentage system, based on the total piece work earnings of the repairmen, including earnings of day work operatives priced under the same schedules. This is probably the most successful system yet evolved for the handling of the laboring problem at large shops. The percentages vary from .05 to .30, according to conditions and work imposed. The matter should be handled under allowance system so that adjustments would only be necessary every third month.

Appendices

APPENDIX NO. 1

The chart shown in Table I. is recommended to shop piece work inspectors or production supervisors for rapid computation of the time required to perform work on lathes and boring mills. The time setting up and removing operation varies of course according to nature of the article, and it will be readily seen that a 1/15-in. feed used with cutting speed of 20 f. p. m. consumes the same time as 1/30-in. feed with speed of 40 f. p. m.

APPENDIX NO. 2

This appendix is submitted for guidance of those inspectors who are constantly confronted with the question as to whether workmen are using proper cutting speed and feeds while they are being timed for purpose of establishing new prices. It is not submitted as a panacea for all troubles, but will be helpful.

The following is a method of determining possible speeds and feeds for turning, boring, shaping, planing and slotting operations on motor driven machines using standard cutting tools at an angle of 75 deg. to 80 deg., assuming that selection, control and application of the motor to machines permit, as they should, using the peak motor load:

Regardless of the cutting speed, feed and cut, it has been found that under average conditions the horsepower required to remove one cubic inch of metal per minute is as follows. (Note—Special metals and cutting tools may cause considerable variation from these constants.)

A.—Mild steel (30 per cent to 40 per cent carbon)	.6
B.—Hard steel (50 per cent carbon)	1.25
C.—Hard tire steel	1.5
D.—Wrought iron	.6
E.—Cast iron, soft, hard	.3 to .5
F.—Brass and similar metals	.2 to .3

TABLE I

TIME IN MINUTES REQUIRED ON TURNING LATHES OR BORING MILLS FOR ANY WORK 1 IN. IN DIAMETER AND 100 IN. LONG

Note—For work of any dimensions multiply the diameter and length by the minutes shown at proper intersection, and then by the constant .01. Result is correct time in minutes. Example: Time required to turn a shaft 3 in. dia. 25 in. long, at cutting speed of 30 f.p.m. and 1/8 in. feed.
$3 \times 25 \times 7 \times .01 = 5.25$ minutes.

Cutting speed— F. P. M. =	Tool Feed in Inch Fractions																	
	1/40	1/30	1/25	1/15	1/12	1/10	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	5/8	3/4	7/8	1 in.
10	104.	80.	66.	40.	32.	26.	24.	21.	18.5	16.	13.5	10.5	8.	5.5	4.2	3.5	3.	2.6
11	94.	72.	60.	36.	28.	24.	22.	19.	17.	14.5	12.	9.5	7.	4.8	3.8	3.2	2.8	2.4
12	88.	66.	56.	33.	26.	22.	20.	17.5	15.5	13.	11.	8.9	6.5	4.5	3.5	2.9	2.7	2.2
13	80.	60.	52.	31.	25.	20.5	18.	16.	14.	12.	10.	8.	6.3	4.1	3.3	2.8	2.5	2.
14	74.	56.	47.	28.	23.	19.	17.	15.	13.	11.5	9.5	7.5	5.9	3.9	3.	2.6	2.2	1.9
15	70.	52.	44.	27.	21.5	18.	16.	14.	12.5	10.5	8.8	7.	5.4	3.7	2.9	2.5	2.	1.8
16	66.	50.	41.	25.	20.	17.	15.	13.5	11.5	10.	8.2	6.8	5.	3.4	2.8	2.3	1.9	1.7
17	62.	46.	39.	24.	19.	16.	14.	12.5	11.	9.5	7.8	6.3	4.8	3.1	2.6	2.1	1.8	1.6
18	58.	44.	37.	23.	18.	15.	13.5	11.5	10.	8.8	7.4	6.	4.5	2.9	2.5	1.9	1.7	1.5
19	56.	41.	35.	22.	17.	14.	12.5	11.	9.5	8.4	7.	5.8	4.2	2.8	2.3	1.8	1.65	1.4
20	52.	39.	33.	20.	16.	13.5	12.	10.5	9.	7.9	6.8	5.25	4.	2.6	2.1	1.75	1.6	1.3
22	48.	36.	30.	18.	14.5	12.	11.	9.5	8.5	7.4	6.	4.8	3.8	2.5	1.9	1.7	1.5	1.2
25	42.	32.	27.	16.	13.	10.5	10.	8.5	7.5	6.4	5.4	4.25	3.4	2.1	1.8	1.6	1.4	1.1
27	39.	29.	25.	15.	12.	10.	9.	7.5	6.8	5.8	4.9	3.9	3.	1.9	1.7	1.5	1.3	0.9
30	35.	26.	22.	13.	10.5	9.	8.	7.	6.	5.4	4.5	3.5	2.8	1.8	1.6	1.4	1.	0.8
32	33.	25.	21.	12.5	10.	8.5	7.5	6.5	5.8	4.9	4.	3.3	2.6	1.7	1.5	1.2	0.9	0.7
35	30.	23.	19.	11.	9.	7.6	7.	6.	5.3	4.5	3.8	3.	2.4	1.6	1.4	1.	0.8	...
37	28.	21.	18.	10.5	8.5	7.	6.5	5.7	5.	4.2	3.5	2.8	2.2	1.5	1.3	0.9	0.7	...
40	26.	20.	16.5	10.	8.	6.8	6.	5.3	4.5	3.9	3.3	2.65	2.	1.45	1.2	0.8	...	...
42	25.	19.	15.5	9.5	7.5	6.3	5.8	5.	4.3	3.7	3.1	2.55	1.9	1.4	1.	0.7	...	...
45	23.	17.	15.	8.9	7.	5.9	5.3	4.7	4.	3.5	2.9	2.45	1.8	1.35	0.9	...	...	...
47	22.	16.5	14.	8.5	6.8	5.6	5.	4.5	3.9	3.3	2.8	2.4	1.7	1.3	0.8	...	...	...
50	21.	15.5	13.	8.	6.3	5.3	4.8	4.3	3.7	3.1	2.7	2.15	1.65	1.2	0.7	...	...	...
52	20.	15.	12.5	7.5	6.	5.	4.6	4.	3.5	3.	2.6	2.	1.6	1.	...	...	...	...
56	19.	14.	12.	7.	5.8	4.8	4.3	3.7	3.2	2.8	2.4	1.9	1.55	0.9	...	...	...	...
60	17.	13.	11.	6.5	5.3	4.5	4.	3.5	3.	2.6	2.3	1.75	1.5	0.85	...	...	...	...
62	16.5	12.5	10.5	6.3	5.	4.3	3.9	3.4	2.9	2.5	2.2	1.65	1.45	0.8	...	...	...	...
66	16.	12.	10.	6.	4.8	4.	3.7	3.2	2.8	2.4	2.	1.6	1.4	0.75	...	...	...	...
70	15.	11.	9.5	5.8	4.5	3.8	3.5	3.	2.6	2.3	1.9	1.5	1.3	0.7	...	...	...	...
72	14.5	10.8	9.	5.5	4.3	3.6	3.3	2.9	2.5	2.2	1.8	1.45	1.2	0.65	...	...	...	...
76	13.5	10.4	8.8	5.2	4.1	3.5	3.1	2.7	2.4	2.1	1.7	1.4	1.1	0.63	...	...	...	...
80	13.	10.	8.3	5.	3.9	3.3	2.9	2.6	2.3	2.	1.65	1.3	1.	0.6	...	...	...	...
82	12.5	9.8	7.9	4.9	3.8	3.2	2.8	2.5	2.2	1.9	1.6	1.25	0.9	0.55	...	...	...	...
86	12.	9.4	7.5	4.7	3.6	3.	2.7	2.4	2.1	1.8	1.55	1.2	0.8	0.5	...	...	...	...
90	11.7	8.9	7.3	4.5	3.5	2.9	2.6	2.3	2.	1.7	1.5	1.15	0.7	0.45	...	...	...	...
92	11.3	8.6	7.	4.3	3.3	2.8	2.5	2.2	1.9	1.6	1.45	1.10	0.6	0.4	...	...	...	...
96	11.	8.4	6.9	4.1	3.2	2.7	2.4	2.1	1.8	1.5	1.35	1.05	0.5	0.35	...	...	...	...
100	10.5	8.	6.5	3.9	3.1	2.6	2.3	2.	1.7	1.4	1.3	1.	0.4	0.33	...	...	...	...

G.—(Lathe)—Cutting speed in inches per minute equals diameter of work, in inches, multiplied by spindle r.p.m. and 3.1416.

G.—(Boring Mill)—Cutting speed in inches per minute equals diameter of work, in inches, multiplied by table r.p.m. and 3.1416.

G.—(Shaper, Planer or Slotter)—Cutting speed in inches per minute equals necessary tool travel in inches per minute.

H.—Area of cut in square inches equals depth of cut (in.) multiplied by tool feed (in. per rev. or stroke), on slotters with inward feeding cutting-tool area of cut in square inches equals width of tool and cut multiplied by feed per stroke.

I.—Cubic inches of metal removed per minute equals G multiplied by H.

J.—Horsepower required to remove *mild steel* would then be A multiplied by I (or .6 multiplied by I).

Note: Power required to reverse planers is more than that necessary to cut metals. On a shaper it is ordinarily less.

K.—Cubic inches of *mild steel* possible to remove per minute is equal to the motor horsepower divided by 0.6.

The following is a method of determining possible speeds and feeds for drilling operations on motor driven presses using standard drills:

The motor horsepower requirements for removing one cubic inch of metal per minute are safely figured at double the constants indicated in A to F inclusive, because of the drill friction and choking caused by movement of chips in holes.

GG.—Cutting speed in inches per minute equals diameter of drill multiplied by drill r.p.m. and 3.1416.

HH.—Area of drill in square inches equals drill diameter squared multiplied by .7854.

II.—Cubic inches of metal removed by drill per minute eqauls *H.H.* multiplied by drill feed in inches per minute.

JJ.—Horsepower required to remove *mild steel* with drill press would then equal *A* multiplied by 2 multiplied by *II* (or 1.2 multiplied by *II*).

KK.—Cubic inches of *mild steel* possible to remove per minute equals the motor horsepower divided by 1.2.

NOTE: With this data available, the speed, feed and cut on any job can be adjusted at will providing the maximum inches of metal removed per minute per motor horsepower does not exceed the values reached in these simple formulae.

APPENDIX NO. 3

The form shown in Fig. 1 is a daily time card for railway shop employees.

DAILY TIME CARD _____ R.S. DEPT.

SHOP _____ Nº _____

NAME _____

RATE _____ DATE _____

CHARGE TO	HOURS DAY WORK	HOURS PIECE WORK
REPAIRING FREIGHT CARS		
SWEEPING FREIGHT REPAIRS		
DELIVERING MATL. FREIGHT REPS.		
OILING FREIGHT CARS		
INSPECTING FREIGHT CARS		
DERAILMENTS		
SWEEPING PASS. REPAIRS		
DELIVERING MATL. PASS. REPAIRS		
OILING PASS. CARS		
CLEANING PASS. CARS		
MISC. WORK ON PASS. REPAIRS		
TOTAL HOURS		

CORRECT _____ FOREMAN

Fig. 1—Daily Time Card

APPENDIX NO. 4

The form shown in Fig. 2 is recommended as one of the best forms available for recording piece work operation studies. It was designed by the writer for both fabricating and assembly shops.

APPENDIX NO. 5

Fig. 3 shows a form recommended by the writer for use in fabricating shops. It shows the labor charges made daily against various shop accounts by machinists, blacksmiths, cabinetmakers, etc. The labor record against each account is shown on a separate perforated section as many of which may be provided as thought necessary. When daily totals for each workman are posted in the time book, the different sections are placed in compartment cases, being used as labor distribution records. Conditions will not permit its use on the New York Central.

APPENDIX NO. 6

Fig. 4 shows a loose leaf time book sheet which answers

SHOP _____ CARD Nº _____

COST AND TIME RECORD FABRICATION SHOPS

DATE _____ 19

NAME	D.W. RATE	KEY Nº								TOTAL HRS.	AMT.	
			PIECE WORK HRS.									
			D.W. HRS.									

APPROVED _____ P.W.I. _____ FOREMAN

	FINISH	PART Nº	CAR Nº	DATE	CHARGE TO
	START				
	HOURS				

OPERATION	CHK. Nº	SCH. Nº	PCS	PRICE	AMOUNT	DW HRS	D.W.R.	D.W. AMT.

Fig. 3—Form Recording Labor Charges.

PIECE WORK RECORD FORM

Operation: Apply 4 corner sill steps. Test No. 3. SK. or B. P. No. ×23520. Sch. No. DD180.
Shop No. 11. Machine..... Mach. No. ..... Jig No. 72.
R. p. m. ..... F. p. m. ..... Cut ..... Feed 1. p. m. ..... H. S. or carbon tool, H. S.
Tools used, 2. Tools bro., 0. Car or S. O. No., 1602. Furnace cap'y, ... Fur. load, ...
Workmen, Smith. Clock Nos. 1121. D. W. rates, 35. P. C. S. per month, 110

No. P. C. S.	Detailed operations	Date	Start	Finish	Ref.	Delay	Mins. per Man	Men	Total mins.	No. P.C.S.	Mins. per piece.	Rate per min.	Cost per piece	P. W. price allowed
4	Steps and all bolts delivered.....	5/7	10:43	10:49	....	...	6	1	6	4	1.5	....	....	....
16	Holes laid out and drilled ⅞ in. by ¾....	..	10:49	11:50	....	...	61	1	61	4	15.2	....	....	....
4	Holes tapped ⅝ in.....	..	11:50	11:59	....	...	9	1	9	4	2.3	....	....	....
4	Stud bolts applied ⅝ in.....	..	1:00	1:08	....	...	8	1	8	4	2.	....	....	....
4	Fitting bolts applied ⅝ in.....	..	1:08	1:17	....	...	9	1	9	4	2.2	....	....	....
4	Steps straightened, sledge delivered.....	..	1:17	1:20	....	...	3	1	3	4	1.	....	....	....
..	Waiting for acetylene torch.....	..	1:20	1:23	....	3	...	1	3	4	1.	....	....	....
..	Sharpening drills	..	1:23	1:27	....	...	4	1	4	4	1.	....	....	....
4	⅝ in. bolts hack-sawed	..	1:27	1:31	....	...	4	1	4	4	1.	....	....	....
4	⅝ in. bolts riveted over.....	..	1:31	1:34	....	...	3	1	3	4	1.	....	....	....
..	Change to other car.....	..	1:34	1:37	....	...	3	1	3	4	1.	....	....	....
	Total	..	....	....	....	...	...	...	113	...	...	....	....	....
	Ten per cent impedence.....	..	....	....	....	...	...	...	11	...	...	....	....	....
	Show machining and setting up separately. Total.	..	....	....	....	...	...	...	124	...	31	....	....	....

Use separate card for each job.
Insert wording of price on reverse side. ....., Shop Insp.
Show weight, kind of metal, etc. .....
...., Shop Foreman. G. P. W. 1.

Fig. 2—Form for Recording Piece Work Operation Studies

our purpose in all assembly and fabricating shops. The card shown in Appendix 8 is used on the New York Central in each type of shop and entries posted on this time sheet.

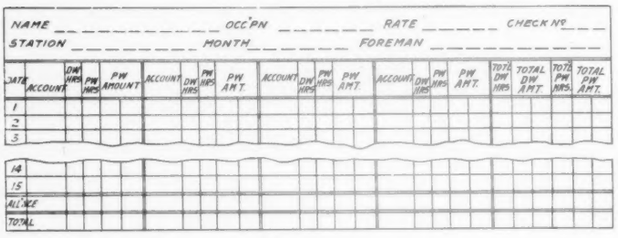


Fig. 4—Loose Leaf Time Book Sheet

APPENDIX NO. 7

FORMULAE FOR DETERMINING SPEED OF GEARS (OR PULLEYS).

Driving Wheel = D.
Driven wheel or follower = F.
Gear teeth (number of) = t.
Speed = s.
Revolutions = r.
Diameter = d.

1.—Given: Dt. Dr and Fd. or Ft.
Required: Fr.

$$\text{Rule: } \frac{\text{Dd or Dt} \times \text{Dr}}{\text{Fd or Ft}} = \text{Fr.}$$

2.—Given: Dd, Fd and Fr.
Required: Dr.

$$\text{Rule: } \frac{\text{Fd} \times \text{Fr}}{\text{Dd}} = \text{Dr.}$$

3.—Given: Dr, Fr and Fd.
Required: Dd.

$$\text{Rule: } \frac{\text{Fd} \times \text{Fr}}{\text{Dr}} = \text{Dd.}$$

4.—Given: Dd and Dr.
Required: Diameter of follower to make a certain number of revolutions in same time.

$$\text{Rule: } \frac{\text{Dd} \times \text{Dr}}{\text{Required No. of revolutions.}}$$

APPENDIX NO. 8

The form shown in Fig. 5 is a cheap and simple form of recording piece work operations performed in assembly departments. It is placed upon a car when it is received on the repair tracks and constitutes the only written record made, serving for inspection record, a guide to workmen,

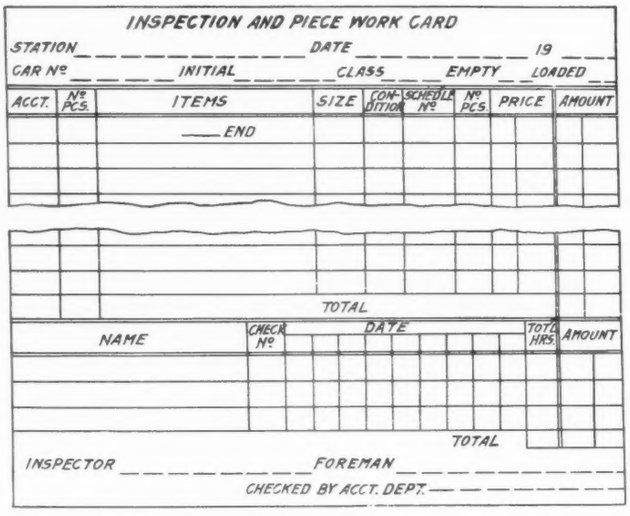


Fig. 5—Form for Recording Piece Work Operations Performed in Assembly Departments.

material distribution reference, M. C. B. billing original and cost record, the piece work money being posted from it in loose leaf time book illustrated in Appendix 6.

METALLIC ELECTRODE ARC WELDS

Suggestions for Determining the Quality of the Joint; Proper Methods Will Insure Good Results

BY O. S. ESCHHOLZ
Research Engineer, Westinghouse Electric & Manufacturing Company

THE lack of a satisfactory method for determining the character of welded joints has been responsible, more than any other factor, for the hesitancy encountered amongst the engineering profession towards the extensive adoption of arc welding. To overcome this prejudicial attitude it is eminently desirable to shape our rapidly accumulating knowledge of the operation into an acceptable method of inspection.

Practically all manufactured apparatus is accepted on the basis of compliance with a process specification rigidly enforced, in conjunction with the successful reaction to certain tests applied to the finished product. While it is commonly known that riveting seriously impairs the strength of the joined plates, yet with a proper layout and intelligent inspection the completed structure possesses certain definite characteristics which do not require further verification. The inspector of a finished concrete structure is practically helpless. It is obvious that the weakest sort of construction may be concealed by a sound surface. With a rigid supervision of the process, however, the physical properties of the completed structure can be reliably gaged to the extent that its use is justified even in ship construction. In view of this, it is comforting to realize that electric arc welding is susceptible of even better control than either of these structural operations.

HOW TO DETERMINE THE CHARACTER OF THE WELD

The factors which determine the physical characteristics of metallic electrode arc welds are: (1)—Fusion; (2)—Slag content; (3)—Porosity, and (4)—Crystal structure.

Some of the more important methods that have been used or suggested for indicating these characteristics are:

(1) Visual examination of weld to determine:
- (a) Surface finish as an index to workmanship.
- (b) Length of deposits, indicating frequency of breaking arc and, therefore, ability to control arc.
- (c) Uniformity of deposit as an indication of the faithfulness with which filler metal is placed in position.
- (d) Fusion of deposited metal to bottom of weld scarf as shown by appearance of under side of welded joint.
- (e) Predominance of surface porosity and slag.

(2) Chipping edges of deposited layers with cold chisel or calking tool to determine relative adhesion of deposit.

(3) Penetration tests indicating linked unfused zones, slag pockets and porosity by:
- (a) X-ray penetration.
- (b) Rate of gas penetration.
- (c) Rate of liquid penetration.

(4) Electrical tests (as a result of incomplete fusion, slag inclusions and porosity), showing variations in:

(a) Electrical conductivity.

(b) Magnetic induction.

The most complete use of these tests would involve their application to each layer of deposited metal as well as to the finished weld. Excepting in rare instances this, however, would not be required by commercial practice in which a prescribed welding process is followed.

Of the above methods the visual examination is of more value than is commonly admitted. In conjunction with it the chipping and calking tests are of particular usefulness. As, however, only a very poor joint will respond to the latter tests, they serve to indicate gross neglect by the operator of cardinal welding principles.

The penetration tests offer the most reliable indication of the soundness of a weld. Obviously, the presence of unfused oxide surfaces, slag deposits and blow holes will offer a varying degree of penetration. The use of X-rays gives excellent results in the test of small samples, but due to the nature of the apparatus, time required and difficulty of manipulating and interpreting results, it can hardly be considered at the present time applicable to large scale production.

The rate of leakage of hydrogen or air through a joint from pressure above atmospheric to atmospheric, or from atmospheric to partial vacuum can be readily determined. However, the equipment required would be quite cumbersome and the slight advantage over liquid penetration in time reduction is not of sufficient merit to warrant consideration for most welds.

Of the various liquids that may be applied, kerosene has marked advantages due to its availability, low volatility and high surface tension. Because of the latter characteristics, kerosene sprayed on a weld surface is rapidly drawn into any capillaries produced by incomplete fusion between deposited metal and weld scarf or between succeeding deposits, slag inclusions, gas pockets, etc., penetrating through the weld and showing the existence of an unsatisfactory structure by a stain on the emerging side. On dissolving suitable oil soluble dyes in the kerosene the pentrating liquid will produce a bright red stain. This test is so useful that it has shown the presence of faults that could not be detected with hydraulic pressure or other methods. A sequence of imperfect structures linked through the weld, which presents the greatest hazard in welded joints, will be immediately located by the kerosene penetration. However, it should be borne in mind that this method is not applicable to the detection of isolated slag or gas pockets, nor small disconnected unfused areas. Nevertheless it has been shown by numerous tests that a weld may contain a considerable amount of distributed small imperfections without affecting appreciably its characteristics.

If the kerosene test betrays a bad fault it is advisable to burn out the metal with a carbon arc before a rewelding under proper supervision. Large quantities of kerosene are preferably removed by means of sand blast, steam, gasolene CCl_4, etc. No difficulty, however, has been encountered on welding over a thin film of the liquid.

Electrical test methods for determining the homogeneity of welds are still in the evolutionary stage. Such obvious difficulties as elimination of the effect of contact differences, influence of neighboring paths and fields, the lack of practicable, portable instruments of sufficient sensitivity for the detection of slight variations in conductivity or magnetic field intensity are yet to be overcome before their employment is feasible.

No simple tests are available, excepting those which involve subjecting the metal to excessive stresses, for determining the crystal structure. Control of this phase must be determined by the experience obtained from following a prescribed process.

While, therefore, the inspector of metallic arc electrode welds may consider that through the proper use of visual, chipping and penetrating tests a more definite appraisal of the finished joint may be secured than is possible in either riveting or concrete construction, the operation may be still further safeguarded by requiring rigid adherence to a specified process.

GOOD RESULTS ARE CERTAIN IF PROPER PROCEDURE IS FOLLOWED

Haphazard welding can no more produce an acceptable product than hit-or-miss weaving will make a marketable cloth. It is logical that the steps in every manufacturing operation should be controlled to obtain consistently good results. Unfortunately, most welders consider themselves pioneers in an unknown art that requires the exercise of a peculiar temperament for its successful evolution. As a result, welding operators, too numerous to mention, enshroud themselves in the hallowed glow of an expert and encompass their work with a mysterious camouflage bewildering to the untutored. Sometimes, through a series of fortunate coincidences, these "experts" succeed in obtaining a good weld, but more often their "success" is attributable to the friction between slightly fused, plastered deposits.

The process of metallic electrode arc welding, in common with all other operations, is readily susceptible of analysis. Regardless of the metal welded with the arc, the cardinal steps are: (1)—Preparation of weld; (2)—Electrode selection; (3)—Arc current adjustment; (4)—Arc length mainteanance; (5)—Filling sequence, and (6)—Heat treatment.

A complete discussion of all of the variations possible in these operations is beyond the scope of this article.*

The preparation of the weld involves sufficient scarfing and separation of the weld shanks so that the entire surface is accessible to the operator with a minimum amount of fill-

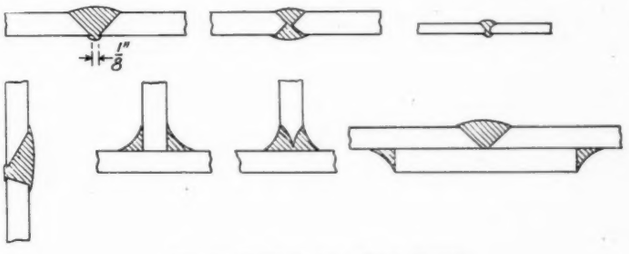


Fig. 1—Typical Arc Weld Scrap

ing required. In addition, where necessary to avoid distortion and internal stresses due to unequal expansion and contraction strains, the metal is preheated or placed so as to permit the necessary movement to occur. Various types of scarfs in common use are shown in Fig. 1.

The electrode selection is determined by the mass, thickness and constitution of the material to be welded. An electrode free from impurities and containing about 17 per cent carbon and 5 per cent manganese has been found generally satisfactory for welding low and high carbon, as well as alloy steels. This electrode may also be used for cast iron and malleable iron welding, although more dependable results, having a higher degree of consistency and permitting machining of the welded sections, can be obtained by brazing, using a copper-aluminum-iron alloy electrode with the aid of some simple flux. The brazing of copper and brass with this electrode also gives very successful results. The diameter of the electrode should be chosen with reference to the arc current used.

THE EFFECT OF TOO LOW CURRENT VALUES

It has been almost universal practice to attempt welding with too low an arc current and the result has been a poorly

*1917 Volume, Association of Iron & Steel Electrical Engineers. "Some Recent Investigations in Arc Welding," by O. H. Eschholz.

fused deposit. This is attributed largely to the overheating characteristic of most electrode holders, on using correct current value, leading the operator to infer that the current used is excessive.

A section through one-half of an exposed joint welded with the proper current is shown in Fig. 2, while Fig. 3 shows the effect of too low an arc current. The homogeneity and good fusion of the first may be contrasted with the porosity and poor fusion of the latter. (These surfaces have been etched to show the character of the metal and the welded zone.)

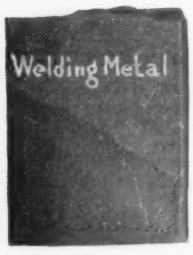


Fig. 2—Good Weld

Fig. 3—Poor Weld

Approximate values of arc current to be used for given thickness of mild steel plate as well as the electrode diameter for a given arc current may be taken from the curve, Fig. 4. The variation in strength of 1-inch square welded joints as the welding current is increased is shown in Fig. 5.

While the electrodes now available are giving quite satisfactory results, it is felt that the electrode development is in its infancy and that considerable strides will be made (with its further evolution) in the ductility of welds, consistency in results, as well as in the ease of utilizing the process.

The maintenance of a short arc length is imperative. A non-porous, compact, homogeneous, fused deposit on a 1-inch square bar from a short arc is shown in Fig. 6, while in

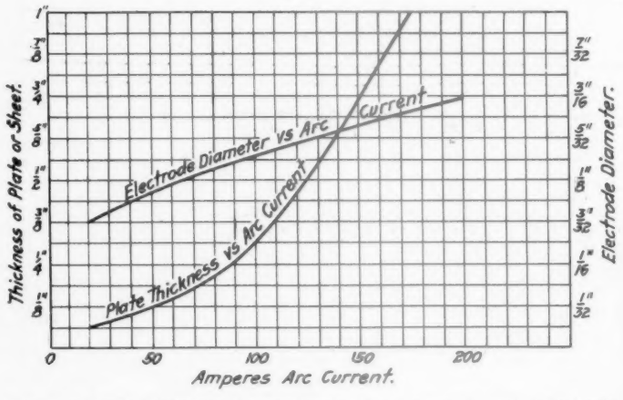


Fig. 4—Chart Showing Approximate Arc Current and Electrode Diameters for Welding Steel Plate of Various Thickness

Fig. 7 is shown a porous, diffused, unfused deposit from a long arc. A skillful operator normally maintains a short arc as the work is thereby expedited, less electrode material wasted and a better weld obtained, due to improved fusion, decreased slag content and porosity. On observing the arc current and arc voltage by meter deflection or from the trace of recording instruments the inspector has a continual record of the most important factors which affect weld strength, ductility, fusion, porosity, etc. It is possible by the use of a fixed series resistance, and an automatic time lag reset switch across the arc to definitely fix both the arc current and the arc voltage, thereby placing these important factors entirely beyond the control of the welder and under the direction of the more competent supervision.

HEAT TREATMENT AND INSPECTION

The method of placing the deposited layers has an important bearing on the internal strains and distortion ob-

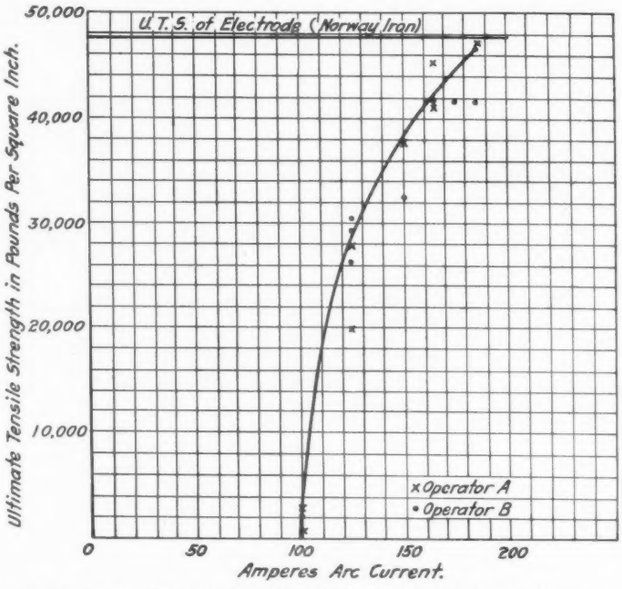


Fig. 5—Variation in Weld Strength With Change in Arc Current

tained on contraction. Part of these strains may be relieved by preheating and annealing, as well as by the allowance made in preparation for the movement of the metal.*

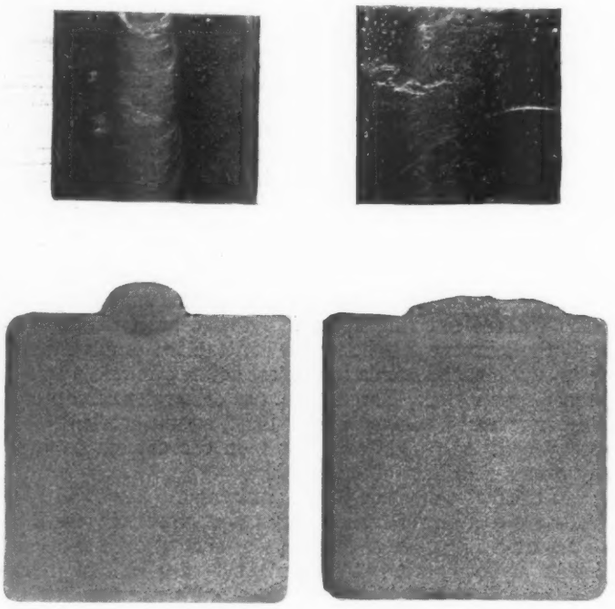


Fig. 6 Fig. 7

Top and Sectional Views of Metal Deposited from Low Carbon Steel Electrode on Steel Stock

In general, heat treatment of a completed weld is not necessary, particularly if it has been preheated for preparation and then subjected to partial annealing. However, in weld-

*Power, June 26, 1917. "Welds—The Weakness and Merits of Their Structure," by P. A. E. Armstrong.

ing even small sections of alloy and high carbon steels a uniform annealing of the structure is desirable if it is to be machined or subjected to vibratory stresses.*

In addition to applying the above tests to the completed joint and effectively supervising the process the inspector can readily assure himself of the competency of any operator by the submission of sample welds to ductility and tensile tests or by simply observing the surface exposed on cutting through the fused zone grinding its face and etching with a solution of 1 part concentrated nitric acid in 10 parts water.

In view of the many resources at the disposal of the welding inspector, it is confidently assumed that this method of obtaining joints will rapidly attain merited recognition as a dependable operation in structural engineering.

HEAT TREATMENT OF AXLES

The Scientific Heat Treatment of Locomotive and Car Axles Made Possible by Use of Electric Furnace

BY DWIGHT D. MILLER
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ONE of the most important metallurgical processes involved in the manufacture of locomotive and car axles is heat treatment, and heat treatment is best carried out and reduced to an exact science through the medium of the electric furnace. In order to appreciate the important part the electric furnace plays in the manufacture of axles, it is necessary to have at least a general knowledge of the composition of steel and the effect of heat treatment upon it.

STRUCTURE OF STEEL

While steel is essentially an alloy of iron and carbon and usually contains impurities in the form of sulphur, phosphorus, silicon and manganese, still its structure is complex and composed of distinct and individual grains which appear in different crystalline formation under the microscope. These various grains are known as cementite, ferrite and pearlite. They are formed during the process of heat treatment and impart varying physical characteristics to the steel. The extent of their formation depends upon the carbon content of the steel.

In the composition of ordinary carbon steel the impurities mentioned above will total about one per cent, while the carbon varies from a few hundredths of one per cent to approximately two per cent. The rest is iron.

EFFECT OF HEAT TREATMENT

If the steel is cooled slowly after being brought to a high heat the carbon always combines with a certain definite amount of iron forming a carbide of iron (Fe_3C) which is the compound cementite. The remaining iron is then carbon free and is known as ferrite. After the formation of cementite and while the cooling process is still going on, the cementit forms a mechanical mixture with a definite amount of ferrite producing a grain structure known as pearlite, which always contains approximately .89 per cent carbon. Hence carbon steel may be divided, according to the difference in the proportions in which the carbon is present as compared to the iron content, into (a) unsaturated (hypo-eutectoid) steel with a carbon content of less than .89 per cent and consisting of pearlite and an excess of ferrite; (b) saturated (eutectoid) steel with a carbon content of .89 per cent consisting wholly of pearlite; and (c) super-saturated (hyper-eutectoid) steel with a carbon content of more than .89 per cent consisting of pearlite plus cementite. This composition is clearly set forth in Sauveur's ferrite-pearlite-cementite diagram.

Hence, since the physical characteristics of slowly cooled steels depends upon the relative proportions of these constituents which vary among themselves in their physical properties, the vital importance of proper heat treatment becomes at once apparent. In fact by applying varying degrees of heat the entire structure of a given steel can be partially or completely changed since it is well known that during the heat treatment of steel evolutions occur in the molecular structure at certain temperatures during both heating and cooling.

The temperatures at which molecular evolutions or changes occur are known as the "critical points." That temperature at which the changes takes place when heating the steel is technically known as the "decalescence" point, while the temperature at which a change takes place when cooling the steel is known as the "recalescence" point.

To quote from the "Heat Treatment of Steel" published by the Industrial Press: "While heating, the steel uniformly absorbs heat. Up to the decalescence point all of the energy of this heat is exerted in raising the temperature of the piece. At this point the heat taken on by the steel is expended not on raising the temperature of the piece, but in work which produces the internal changes here taking place between the carbon and the iron. Hence, when the heat added is used in this manner, the temperature of the piece, having nothing to increase it, remains stationary, or owing to surface radiation, may even fall slightly. After the change is complete the added heat is again expended in raising the temperature of the piece, which increases proportionally.

"When the piece has been heated above the decalescence point and allowed to cool slowly, the process is reversed. Heat is then radiated from the piece. Until the recalescence point is reached, the temperature falls uniformly. Here the internal relation of the carbon and iron is transformed to its original condition, the energy previously absorbed being converted into heat. This heat, set free in the steel, supplies, for the moment, the equivalent of that being radiated from the surface, and the temperature of the piece ceases falling and remains stationary. Should the heat resulting from the internal changes be greater than that of surface radiation, the resulting temperature of the piece will not only cease falling but will obviously rise slightly at this point. In either event the condition exists only momentarily, but when the carbon and iron constituents have resumed their original relation the internal heating ceases, and the temperature of the piece falls steadily, due to surface radiation." The temperature variations referred to are clearly shown in Fig. 1.

The general term "heat treatment" includes three distinct and separate operations. They are: (1) Hardening in which the steel attains its hardest and most brittle state; (2) Annealing, in which the steel attains its softest and toughest state; (3) Drawing or tempering, in which the steel attains an intermediate condition. These operations constitute the complete cycle of heat treatment.

Hardening consists of heating the steel uniformly above the

*Railway Mechanical Engineer, February, 1918. "Microscopic Study of Welded Tires," by S. W. Miller.

decalescence or critical point and then cooling it rapidly in some medium such as water, oil or brine. The temperature to which it is necessary to heat the steel above the critical point depends upon the carbon content. It is not advisable to heat much above the critical point since an increased temperature tends to enlarge or coarsen the grain, wastes fuel and has no appreciable effect on the hardening process.

The nature of the quenching medium however, does affect the results obtained. Greater hardness is obtained by quenching in salt brine than in water, while water quenching pro-

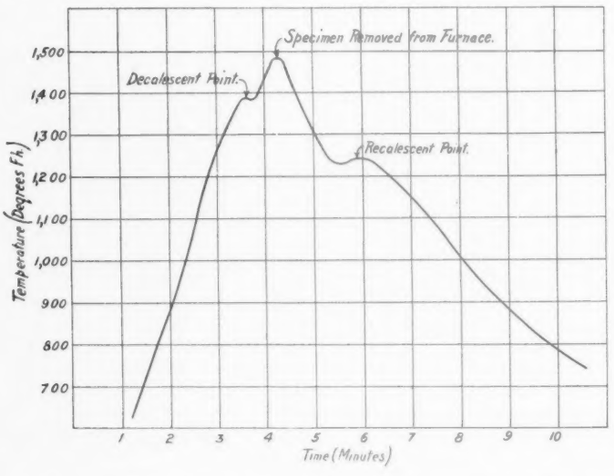


Fig. 1—Temperature Changes in a Piece of Steel Uniformly Heated and Allowed to Cool

duces greater hardness than oil quenching, the temperature in all cases remaining the same. Likewise the physical properties are materially affected by the rate at which the steel is cooled and the length of time it is immersed in the quenching bath.

In general the process of annealing consists of slow cooling from a high temperature at or above redness. The object of this treatment is to either: (1) Completely undo the effect of hardening, leaving the steel in its softest and most ductile condition; (2) Refine the grain to obtain the desired strength, or, (3) Remove any stresses and strains set up by too rapid cooling, especially if the rate of cooling is different in different parts of the piece, also those caused by forging and cold working. To accomplish (1) and (3) it is sufficient to heat below the critical point, but for grain refining (2) the temperature must be raised above the critical point. In practice, cooling during this process is effected by leaving the piece in the furnace at a reduced temperature or allowing it to cool in the air.

The process of tempering or drawing has for its object the partial removal or moderation of the effect of previous hardening. The operation consists of heating the piece to a somewhat lower temperature than for the purpose of hardening, not allowing it to reach the critical point, and then cooling it slowly in air. This treatment decreases the hardness and increases the toughness of the steel. The degree of these changes is governed by the temperature used for reheating, its uniform penetration into the metal and the length of time the metal is subjected to it.

From the foregoing it is apparent that the accurate control of temperature is of prime importance in all heat treatment. If the temperature is too low the results sought are not attained, while if the temperature is too high the steel is "burned" resulting in total loss.

The necessary heat treatment will depend on the quality of steel needed for locomotive and car axles and attention is called to the standard specifications of the American Society for Testing Materials and the American Electric Railway Association.

STANDARD SPECIFICATIONS FOR AXLE STEEL

	A. S. T. M.	A. E. R. A.	Electroheat
Ultimate strength, lb. per sq. in.	85,000	85,000	95,000
Elastic limit, lb. per sq. in.	50,000	50,000	60,000
Elongation in 2 in., per cent.	20.5	22	20
Reduction of area, per cent.	39.	45	40

That these specifications can be met and are being materially bettered in some respects in daily commercial practice is shown by reference to column three in the above table. Under the heading of "Electroheat" are given results obtained by the Laclede Steel Company of St. Louis, Mo., which makes use of an electric furnace for heat treating car axles.

ELECTRIC FURNACE FOR HEAT TREATING

The electric furnace used is known as a resistance or reverberatory type in that the heat generated is reflected mainly from the roof onto the charge under treatment. On either side of the furnace running back through the entire depth, are the two resistor troughs, supported on brick piers which serve to conduct the heat generated in the trough material and diffuse it uniformly, thus avoiding hot spots in the refractory lining of the furnace in their immediate vicinity. The troughs are open at the top, being filled with resistor material consisting of finely broken carbon or graphite which becomes incandescent throughout the entire length of the trough at the passage of electricity.

The heat of these huge filaments is radiated to the roof and from there reflected back onto the hearth of the furnace and the material under treatment.

The furnace is charged by means of a car on which the charge to be treated is loaded as shown in Fig. 2. This car runs on rails and is operated by suitable worm and spur gears actuated by an electric motor the entire mechanism being located underneath the flooring.

This construction provides an efficient and durable heat treating furnace. The losses due to heat radiation are small,

Fig. 2—Electric Furnace and Charging Car

and both the atmosphere and temperature can be controlled to a remarkable degree of accuracy.

The furnace has a capacity of 1,000 lb. per hour when heating to 1,650 deg. F. It is rated at 150 kw. and designed for 2 phase, 25 cycle operation. The voltage used will depend upon the resistance of the resistor material in the trough and is stepped down through transformers from 13,000 volts supplied from the central station. In this particular case the voltage used varied from 150 down to 70 volts according to the heat requirements of the operation.

The usual instruments such as wattmeters and switches necessary for the proper operation of the furnace are installed upon the switchboard, together with a pyrometer by means of which an accurate record of the furnace temperature is obtained at all times.

The operation of the furnace is simple. Upon closing the main switch, current at full rated voltage is sent through the resistor material in the trough which is a poor conductor of electricity, especially when cold. The resistance to the flow of current transforms the electrical energy entering the troughs into heat energy and the furnace begins to heat up. Due to the negative temperature coefficient of the carbon or graphite resistor material it becomes a better conductor the hotter it gets so that as its conductivity increases its resistance decreases and more current flows. This fact is duly indicated by the instruments on the board and when the power input tends to become excessive it is cut down and held constant by lowering the voltage by means of an operating transformer provided for its control. The time it takes to bring the furnace up to desired temperature depends of course on whether the furnace is cold or already partially heated and upon the process to be performed.

Fig. 3—Dipping the Axles in the Cooling Tank

At the plant of the Laclede Steel Company the raw material for axles is received in the form of steel billets running around .35 to .50 per cent carbon. These billets are forged to the proper shape and size. After being allowed to cool in the air they are loaded in a cradle on the car of the electric heating furnace. It should be noted from Fig. 2 that each separate piece is so loaded that there is free air space completely around it. This is to enable the heat to reach all parts of each piece and penetrate uniformly. When properly loaded the car is run into the hot furnace and the axles allowed to soak for a certain definite time.

After heating at about 1,600 deg. F. the car is run out and the cradle with its load lifted off by an air hoist and immediately quenched in a water tank situated near the furnace and shown in Fig. 3. The charge, is then put back into the furnace and held there during a definite period at a drawing temperature of about 1,200 deg. F.

The advantages of the foregoing method of heat treating car and locomotive axles are largely due to the use of the electric furnace and may be summed up as follows:

(1) The accurate control of temperature, together with a clean heat provides a product of superior physical characteristics and grain structure—meaning longer life.

(2) Electric measuring instruments and the pyrometer make possible the exact duplication of conditions and prevent loss of material due to improper treatment—meaning less rejections.

(3) The uniformity of heating and absorbtion of heat by radiation tends to eliminate all internal strain due to uneven heating.

(4) Since electric energy in practically all cases is furnished by central stations with highly efficient power units there is a big saving in coal.

(5) The absence of noise, gas fumes and smoke and large heat radiation greatly improve the conditions of labor.

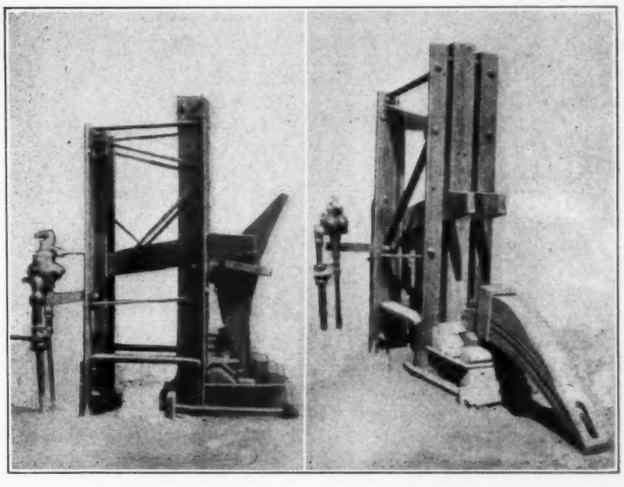
An electric furnace could be used in railroad repair shops with much benefit in overcoming the stresses and strains set up in the repaired metal parts.

SPRING STRIPPING MACHINE

BY J. M. MAC DONALD
Blacksmith Foreman, Maine Central, Portland, Maine

The spring stripping machine shown in the illustration has given particularly good service. It is about 7 ft. high and is comparatively simple in construction. The main framework is built of ¾-in. by 4-in. by 6-in. angles suitably bolted together and braced with 1-in. by 3-in. iron. This framework fits in a concrete base on which rests a cast iron block cut out to suit the ends of the springs. There are two levers made of 1½-in. by 7-in. stock, tapered at the end to about 4 in. as indicated. These levers are proportioned to give a ratio of 15 to 7, and the fulcrum bolt, which fits in holes in the angle iron, may be adjusted for different heights, depending upon the length of the spring.

Power to operate this machine is furnished by means of a 12-in. by 10-in. air cylinder, suitably bolted to the bottom of the framework. This cylinder is not plainly shown in the illustration but operates on the left hand end of the levers to force them up. The supply of air is controlled by a G-6 brake valve. With an average pressure of 90 lb. per sq. in. in the cylinder, it is possible to obtain from 12 to 25 tons pressure on the spring band, depending on the position of the levers.



Spring Stripping Machine Used on the Maine Central

In operation, the spring which it is desired to strip is upended on the concrete base, as shown at the left, and the fulcrum bolt adjusted to the hole which is best suited to the length of the spring. A yoke which has been cut out just wide enough to slip on over the spring above the band is then put in place and the air pressure applied. In starting the band as short a leverage as possible should be used, thus giving a greater pressure on the band. As a rule, when the band has been started, the spring leaves loosen up so that it

is comparatively easy to finish taking off the band as shown at the right of the illustration.

After this machine was built it was found necessary to apply a rubber bumper at the top to relieve the shock when the band gives way. By having a set of yokes suited to the width of the different standard springs, it is possible to use this machine for any spring on the system with no adjustment except for the length.

THE LOSSES IN A SMALL POWER PLANT

BY A. G. D.

Sometime since I had occasion to make a rather complete test of the power situation in a steam railway car shop, located near Cincinnati and belonging to a well-known company. The result of the analysis brought to light several ways in which power is lost or dissipated that do not often appear. The power was supplied by a 14-in. by 30-in. Vilter Manufacturing Company Corliss Engine, which was belted to a main shaft, so located that the belt ran upwards at an angle of about 60 deg. from the horizontal. A 22.5-kw. generator was belted to the main shaft and this furnished electric lights and current for charging batteries.

The equipment in the shop was briefly as follows: The machine and blacksmith shop contained grinders, emery wheels, lathes, planer, drill press, forges, and other similar machine tools—in all totaling eighteen. The polishing room contained two buffers and a drill, three tools in all, The laundry contained a washer, wringer, hair and feather picker—four machines. The carpenter shop contained a blower, saws, stitcher, woodworker, planer, lathes, etc.—fourteen machines in all.

The Corliss engine was called upon, therefore, to operate the electric generator and thirty-nine machines.

An all day test was made on the plant, weighing the coal, taking indicator cards every ten minutes to get the average load, and cards at noon to get the power in overcoming the engine, generator belt and shafting friction and losses.

The average distribution of the total indicated horse power was as follows:

Engine friction and loss	7 h.p.	11.5 per cent
Generator losses	3 h.p.	4.9 per cent
Shafting and belt losses	19.7 h.p.	32.3 per cent
Generator output (in horse power)	25 h.p.	41.0 per cent
Fower to operate 38 tools all shaft and belt driven	6.3 h.p.	10.3 per cent
Total	61 h.p.	100 per cent

The loss of 32 per cent in belt and shaft friction is somewhat above the average encountered in the ordinary plant and should be cut down, while an average of 48.7 per cent of the energy developed in the engine cylinder, being absolutely lost is worthy of attention.

The engine itself operates about as well as any I have ever seen. The speed was taken at regular intervals throughout the day and it ran from 100 to 102 revolutions per minute—i. e., with better than two per cent regulation.

Regular readings of the voltage of the generator were taken as part of the data. The normal voltage was 117. Now with a direct current generator with a constant field excitation, the voltage from the generator is a direct measure of speed. The voltage varied from 117 to 108 with an average throughout the day of 113½, or 3 per cent below normal. This showed that the generator was running 3 per cent slower than normal, and so consequently was every machine in the shop. The test was started at 7 a. m. The voltage held steady at 117 until 8:20 a. m., then it gradually began to go down until 10 a. m., when it reached 115 volts; then suddenly it dropped to 110 volts and then 108 volts. I couldn't imagine what was the matter. The engine speed remained constant and the load the same. Finally a man came in with a bucket and threw resin on the belt. Immediately the voltage went back to 117 volts, and remained there until in the afternoon there was a repetition of this performance.

The main belt from the engine to the line shaft slipped 7.7 per cent, which made of course the loss at every machine. Thus a lathe was doing 7.7 per cent less work than it should with corresponding loss in production. The storage battery charging room suffered the most. They were drawing a charging current of 180 amperes, at 117 volts; when the voltage dropped to 110 volts the current dropped to 145 amperes, and when the voltage reached 108 volts the charging current was 130 amperes. I found afterwards that one of the plant men was the official resin thrower.

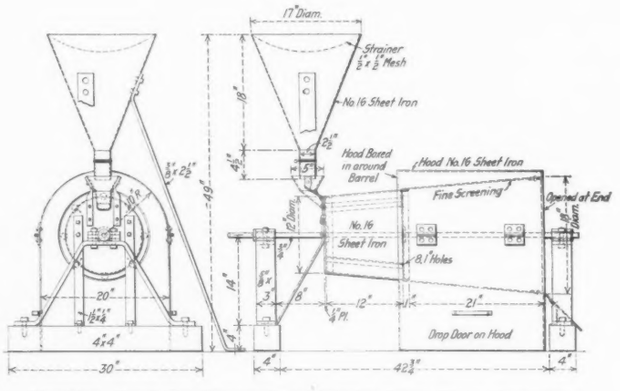
Primarily, a belt inclined at an angle of 60 deg. is a rather poor proposition. Matters could be made considerably better by an idler pulley used as a belt tightener. The whole load and plant was an ideal proposition for purchasing current from a Central Station, but with that engine, an investment in a 75-kw. generator and motor drive would soon pay for itself.

BABBITT SEPARATOR

BY J. V. HENRY

An effective machine for reclaiming babbitt which drops on the floor around furnaces and tables is shown in the illustration. It is an improvement over the method of reclaiming babbitt from floor sweepings by placing the sweepings in the melting pot, and skimming the dirt off the top. With the use of the separator there is less danger of foreign substances getting into the babbitt and affecting its quality.

The construction of the machine is plainly indicated. After sufficient sweepings have accumulated in the large funnel to warrant operation, they are lowered into the first drum by means of the damper and small funnel and the machine started. As the drum revolves the larger pieces



Machine Used for Separating Babbitt from Floor Sweepings

of babbitt coming in contact with the 1-in. by 1-in. angles riveted to the barrel, are broken up, liberating any dirt that they might contain. The babbitt and dirt then pass through the eight 1-in. holes into the second drum made of fine screen, from which the dirt drops to the floor while the babbitt passes out of the end and down the chute. The screen drum is covered with a hood which prevents any dust from flying around the shop.

The machine may be either belt or motor driven and should revolve at about 25 r.p.m.

INCREASED RAILWAY FARES IN IRELAND.—The recent increase in ordinary passenger fares by 50 per cent on the railways in Great Britain was ordered to apply to Ireland from June 1.

SYSTEM FOR PREPARING JOURNAL BOX PACKING

The preparation and the resaturation of waste used for packing journal boxes when done by the usual method is an unpleasant job. Most roads require that waste shall be submerged in oil for 24 hours and drained from 24 to 48 hours. Often packing is made up in large quantities and becomes very dry before being used; this results in hot boxes or a waste of lubricant, through the excessive use of free oil, either of which is costly.

A system which overcomes the disadvantages of ordinary

Milwaukee Waste Saturating Tanks

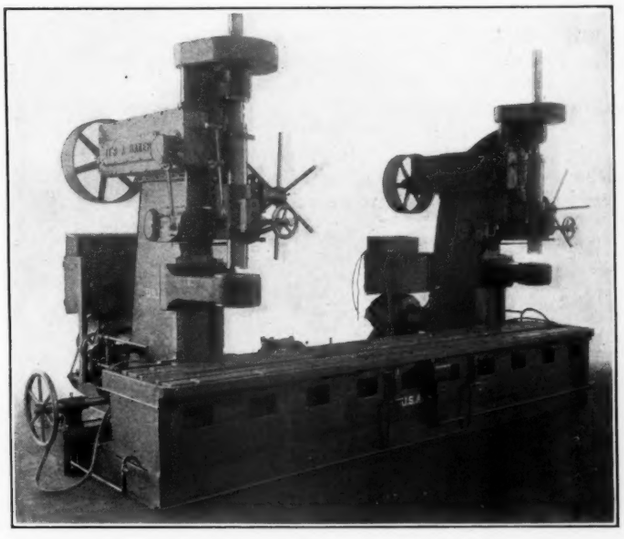
vats has been placed on the market by the Milwaukee Tank Works, Milwaukee, Wis. This consists of tanks with an oil reservoir in the lower part and a waste compartment in the top. A pump is attached to the tank, so that the oil can readily be lifted to the upper section. When it is desired to prepare some packing, the waste is placed in the top of the tank and the oil is pumped over it. When it has been immersed for a sufficient length of time, a valve is opened to allow the oil to flow into the bottom tank, leaving the waste to drain on the screen. If the waste becomes too dry it can be saturated again without removing it from the vat. A gage stick at the rear of the tank shows the amount of oil remaining in it. The bottom of the tank can be cleaned, if necessary, through an opening in the front provided for that purpose. The tanks are manufactured in various sizes. All are closely riveted and soldered and are fitted with dust-proof covers.

The use of properly saturated waste without the addition of free oil is recognized as the most desirable practice for insuring efficient and economical lubrication. The Milwaukee saturating system helps toward the attainment of that end by reducing the time and labor required for the proper preparation of packing.

BAKER ROD DRILL

A new rod drill (type 4-K) has been built recently for the use of the United States Engineering Corps abroad by Baker Brothers, Toledo, Ohio. This is a special machine for railway work, and consists of two high speed drills adjustable along the base to bore rods of different lengths. The general arrangement of drills and base is shown in the illustration.

The two units used in making up the rod drill are the standard No. 513 Baker drills, and both machines are driven by independent motors. A special traversing motor moves either or both of the drills horizontally as may be desired.



Baker Brothers 4-K Rod Drill

Both units are equipped with a steady support for the boring bar and the table is arranged with ample pockets for receiving the lubricant. Ample T-slots are provided for clamping the rods to the table.

The design of this drill is such that in boring, drilling, forming and facing, a 5/8-in. high speed drill may be driven

to the limit of its efficiency. Particular attention has been given to the location of all operating levers, which are so placed as to minimize the work of the operator in changing feeds, speeds and making table adjustments. The machine is started and stopped from the front. Instantaneous change from drilling to reaming speeds is also provided.

A constant speed drive is furnished through a train of hardened gears running on annular ball bearings encased in an oil-tight box. Annular ball bearings are used throughout this machine. The feed arrangement is simple and rugged, and 24 different feeds in all are provided, 12 drilling and 12 reaming feeds. The feed rack is of steel and the feed pinion meshing with it is cut direct on the shaft. A large bronze worm gear with provision for securing uniform wear, and a safety pin to protect the feeding mechanism from abuse is provided. The shear pin has been set to shear at 14,000 lb. There is an automatic depth stop with fine adjustment. Capstan handles are provided for rapid vertical traverse; in addition, hand worm feed is provided.

The machine is started and stopped by means of a shifting belt on tight and loose pulleys, the loose pulley running on ball bearings. A spring device holds the belt securely in position. In the "off" position a brake is applied in such a manner as to quickly stop and hold the spindle. This not only saves time, but is a safeguard to the workman while changing tools. The following are the general dimensions of the machine:

Capacity, high-speed drill in solid steel, 5 in.; distance, center of spindle to face of column, 18 in.; distance, end of spindle to plain table, 45 in; length of feed, 18 in.; diameter of spindle sleeve, 5.25 in.; Morse taper in spindle, No. 6; twelve drilling feeds, .006 to .032; twelve reaming feeds, .020 to .108; eight speed changes, 11 to 151; driving pulley, 20 in. by 5¼ in.; speed of pulley, 600 r.p.m.; size of motors required, 15 hp.—1,200 r.p.m.

NEW TYPE OF MACHINE FOR WOODWORKING

In woodworking shops there is still a large amount of hand planing done, even though the plant may have a very complete equipment of machinery. Some jobs are too small for the jointer and if a single piece is to be surfaced, taking it to the machine is a wasteful practice due to the time lost on the trip and waiting for the machine to come up to speed. The demand for a tool to handle small pieces and short runs has led to the development of the Wallace bench planer, an illustration of which is shown in connection with this article.

This machine will do surfacing, mitering, beveling, jointing, rabbeting, etc. While it is large enough to accommodate three quarters of the power planing done in the average shop it will handle pieces as short as three inches in length. It will take heavy cuts in hard or soft wood, yet requires so little power that it can be connected to an ordinary electric light socket. It takes a finish cut so smooth that no sand papering is needed. The entire machine is portable and does not require fastening to the bench.

A Portable Wood Planer

The table of the Wallace bench planer is 19 in. long and is adjustable for any depth of cut. The throat opening is less than 1 in. The knives are 4 in. wide and are completely protected by the flap and shutter guards. The machine is regularly furnished with the cutter head direct connected to a one-fourth horse power motor for either alternating or direct current. If desired, however, it can be supplied with a pulley and countershaft for belt drive. The fence is adjustable to any angle for beveling and similar work. The bench planer is used by a large number of pattern and cabinet makers and several have been installed in railroad shops. The manufacturers of the machine are J. D. Wallace & Company, Chicago.

ANDERSON VALVE GEAR

A new form of valve gear has been devised and a patent applied for by J. A. Anderson, master mechanic, Baltimore & Ohio, Grafton, W. Va. The motion of the valve is the same as that obtained with the usual form of Stephenson gear, but the eccentric motion work is removed from between the frames and applied to the outside, using a double crank arm as a substitute for the eccentrics and straps. This affords an outside valve motion with a variable lead.

Stated briefly, the special features of this form of valve gear are its simplicity, accessibility for oiling, ease of maintenance and variable lead. By eliminating the use of eccentrics and straps, the amount of friction is reduced and there are no heavy revolving parts. A further advantage is the elimination of heavy rocker boxes and long transmission rods, which in most cases are curved and subject to considerable distortion. Of course, the removal of the motion work from between the frames permits better bracing of the locomotive frames, which in turn has a tendency to reduce frame breakage.

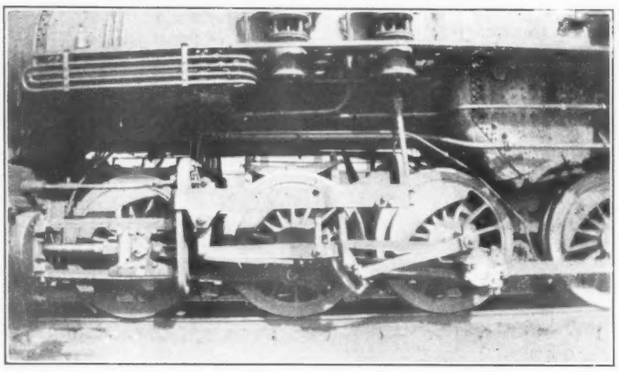


Fig. 1—The Anderson Valve Gear Applied to a B. & O. Locomotive

A Baltimore & Ohio locomotive is shown in Fig. 1 equipped with the Anderson valve gear, and Fig. 2 shows in plan and elevation how the gear is applied.

The principal part of the gear is a double crank arm fastened to the end of the main crank pin, as shown. This crank arm is forged in one piece and has two pins which take the place of eccentrics. They are located in the following manner: Keyway points are located on the axle, the same as for the Stephenson gear; lines are drawn from the center of the axle through these points and distances spaced off equal to one-half the valve travel, or the radius of eccentricity; then the crank arm is designed to have arms so located as to fall on lines through these points parallel to the center line of the axle, the smaller arm being extended from the outer end of the pin on the crank pin arm. The

motion is transmitted through a link similar to that used in the eccentric link motion. The links are raised and lowered in the same way as with the inside eccentric motion, except for the difference in the location of the reverse shaft arms.

The double eccentric crank arms are designed to be interchangeable on each class of locomotive. After once applying in accordance with specifications there is no necessity for any changes or adjustments such as are frequently necessary in the Stephenson gear, due to eccentric wear.

In comparing this device with other outside locomotive valve gears, the double crank arm makes it possible to take all the motion transmitted to the valve from the axle and secure a variable lead.

The Baltimore & Ohio locomotive shown was equipped with the Anderson valve gear at the Glenwood shops, Pittsburgh, Pa., and has been in service for several months. It is understood that plans are under way for applying the valve gear to three different classes of locomotives for a more extensive test.

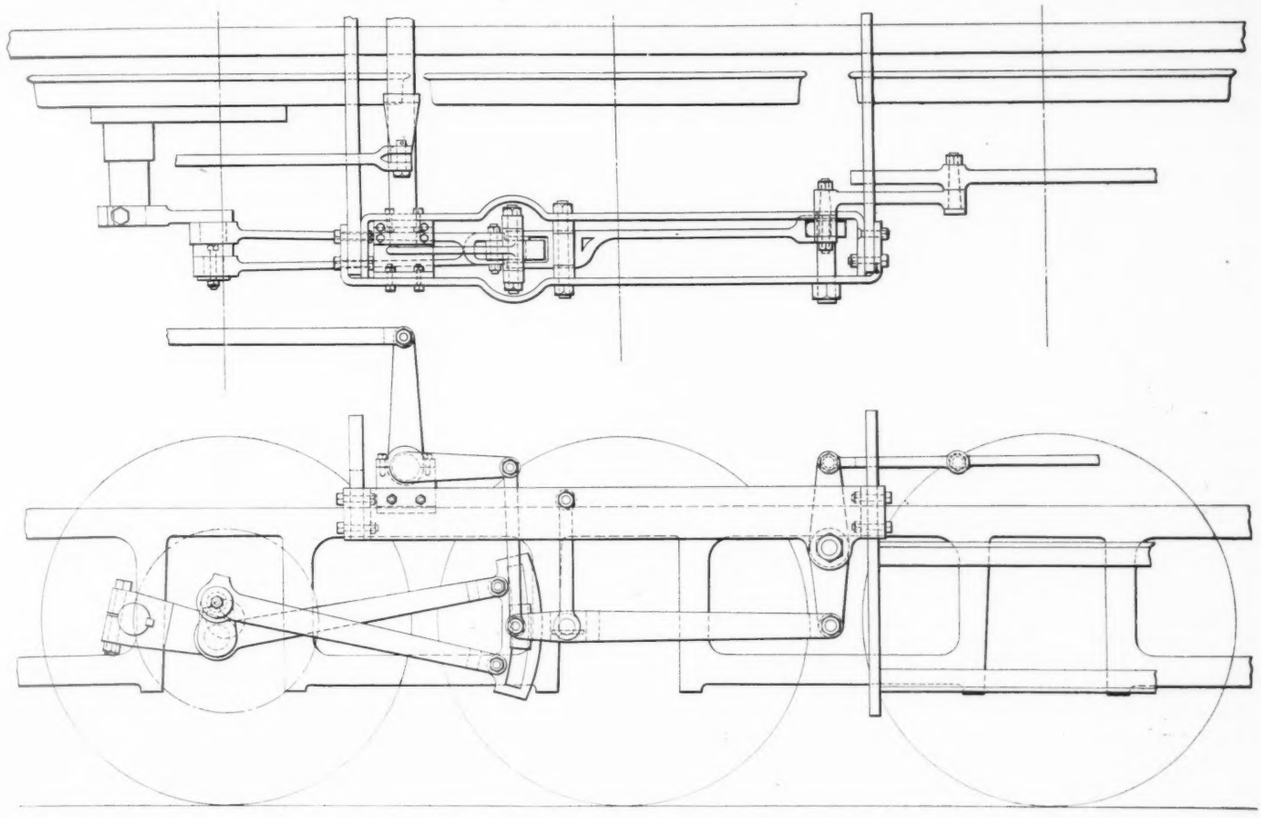


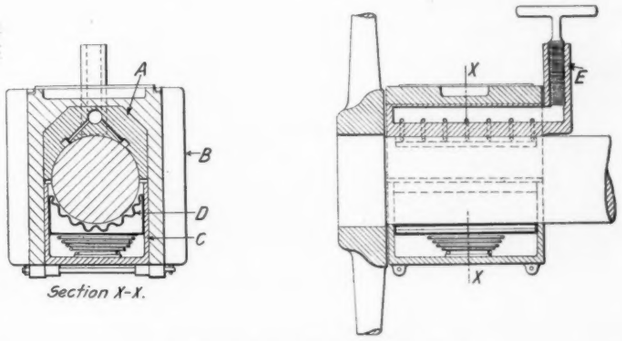
Fig. 2—Plan and Elevation of Anderson Valve Gear

FUEL OIL CONSUMPTION BY RAILROADS IN 1917.—The Geological Survey reports that the immense increase in railroad traffic has increased correspondingly the quantity of petroleum consumed as locomotive fuel in 1917, despite the mounting cost and growing scarcity. Statistics compiled from reports submitted by all railroad companies that operated oil-burning locomotives in the United States show that the quantity of fuel oil consumed by them in 1917 was 45,707,082 barrels, or 8.5 per cent over 1916, and a larger consumption than in any other year. The total distance covered by oil-burning engines in 1917 was 146,997,144 miles, and the average distance covered per barrel of fuel consumed was 3.2 miles. Oil-burning locomotives were run on 32,431 miles of road in 21 states.

TRUCK BOX LUBRICATOR

The advantages resulting from the use of hard grease on locomotive journal and crank pin bearings are well known and it would probably be used even more than it is except for the difficulty in applying it to certain bearings. Hard grease has been used for the lubrication of locomotive driving journals since 1905 and at the present time it is probable that 90 per cent of the locomotives in the United States and Canada have driving journals fitted for the exclusive use of hard grease as a lubricant.

Up to date, however, very little has been done to extend the use of hard grease to engine truck and trailer journals.



The Martin Truck Box Lubricator

The accompanying illustration shows a hard grease truck box lubricator patented by J. C. Martin, Oakland, Cal.

It is generally agreed that whenever possible the best place to apply lubricant to a journal is at the top, where the load is carried. This is especially true of engine truck and

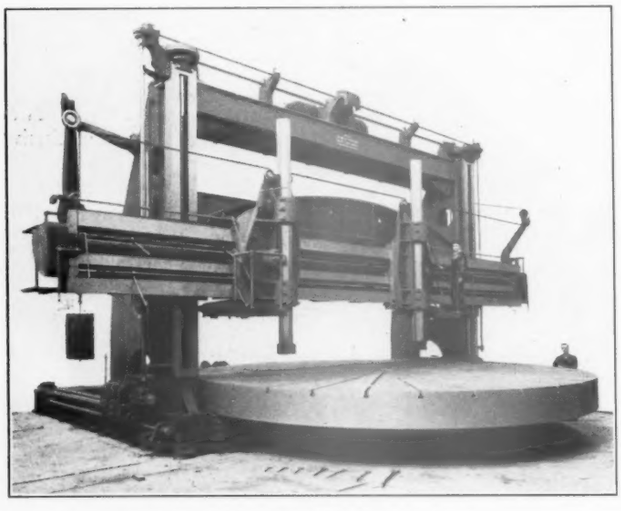
trailer journals where there are no reciprocating parts and the constant load tends to pinch out what lubricant is between the bearings and prevent any more from getting in. This condition is met in the Martin bearing by forcing the hard grease into the bearing from the top. Referring to the illustration, *A* is the special crown brass bearing with a centrally cored out section and a series of channels connecting it with longitudinal grooves on either side of the center line and near the top of the journal. The hard grease is inserted through a threaded extension of the cored out section of the bearing, which is fitted with a screw plug, as indicated at *E*. The journal bearing *A* fits in the box *B*, in the customary manner. The cellar *C* is provided with a corrugated tray *D*, which is held against the bottom of the journal by a coil spring. This tray serves the purpose of conserving the lubricant as it passes downward to the under side of the journal and allows it to be used over again.

In operation the cored out section of the journal bearing is filled with hard grease by means of the plug, and as the locomotive is run the grease gradually works to the bottom of the journal, filling the corrugated tray, thus insuring economical and complete lubrication of the bearing.

It is claimed for the Martin lubricator that it reduces locomotive failures due to melted out truck bearings, that it requires but little attention and materially reduces the cost of lubricating truck journals. In service the operation of the device has proved satisfactory during a trial of nearly two years' duration.

EXTENSION BORING MILL

The 28- to 42-ft. extension boring and turning mill illustrated, was built recently by the Niles-Bement-Pond Company, 111 Broadway, New York, for arsenal work. While this machine would not be applicable to railway shop work, it is of interest because of its immense size. The swing of the machine is 28 ft. 2 in. with the housings forward, and 42 ft. 4 in. with the housings back. The maximum height under the tool holders is 10 ft. and the bar travel is



28-Ft. Boring Mill for Arsenal Work

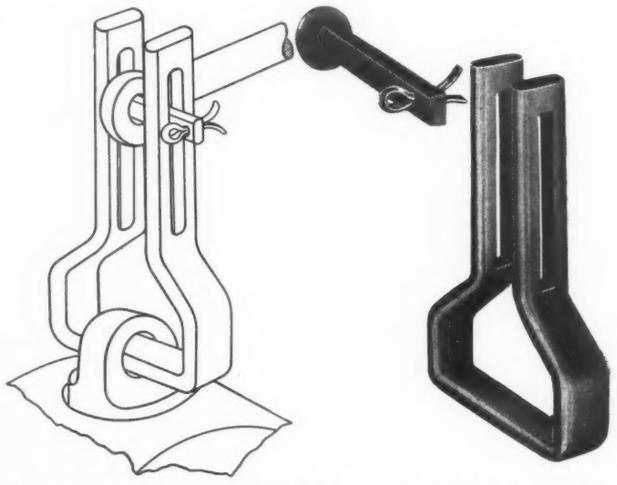
84 in. The table is driven by a 16-hp. motor through a double pinion drive. A 25-hp. motor is used for elevating the crossrail and a 15-hp. motor for fast traversing the bars and saddles. A separate 15-hp. motor is used for traversing the housings.

The crossrail has two heads with octagon bars 10 in. across the flats. The crossrail is 48 in. in width and 54 in. in depth from front to back.

The table is designed to carry safely a load of 300,000 lb. in addition to its own weight. It is driven by two forged steel pinions, one located on each side. The heads on the crossrail are provided with platforms for the operator, and an idea of the size of the machine may be obtained by noting the relative size of the two operators in the illustration. The adjustment of feeds and rapid traverse for bars and saddles is controlled from the platforms. The main driving motor is also controlled from these platforms, as well as from stations at each side of the machine. Push button control is provided for all motors.

STA-RITE UNCOUPLING LEVER ATTACHMENT

The reports of the division of safety of the Interstate Commerce Commission indicate that uncoupling chains are responsible for more than half the defects of the uncoupling mechanism. The adoption by the railroads of other devices to replace uncoupling chains has been recommended by the division of safety. A simple and efficient substitute for the uncoupling chain is now being made by the Railway Devices Company, St. Louis. This device which is known as the Sta-



Method of Application and Details of Sta-Rite Uncoupling Attachment

Rite Uncoupling Lever Attachment requires no change in the M.C.B. uncoupling levers for its application. It consists of but three pieces, the link and pin which are of cast steel and the cotter pin. The construction is such that the parts cannot get out of place, or cause trouble due to kinking or fouling, and sufficient flexibility is provided to take care of all movements of the coupler. The design of the device and the method of application are clearly shown in the illustration above.

WHEN CARBON MONOXIDE IS FATAL.—Carbon monoxide has an avidity for hemoglobin, the red coloring matter of the blood, with which it forms the same combination as does oxygen, only 250 times as powerful. However, this combination is not permanent and a man brought out to the fresh air, or to whom air mixed with oxygen can be administered, will generally recover if exposure is within the following limits. As a rough estimate, it may be stated that usually a man will die who has breathed 0.2 per cent of carbon monoxide mixed with air which is in other respects normal, for four or five hours, or 0.4 per cent for one hour. With from two to five per cent of carbon monoxide death follows almost as quickly as in drowning.—*Journal of the American Medical Association.*

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WE GUARANTEE, that of this issue 6,900 copies were printed; that of these 6,900 copies 5,870 were mailed to regular paid subscribers, 144 were provided for counter and news companies' sales, 195 were mailed to advertisers, 180 were mailed to exchanges and correspondents, and 511 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 56,300 an average of 8,043 copies a month.

The RAILWAY MECHANICAL ENGINEER is a member of the Associated Business Papers (A. B. P.) and of the Audit Bureau of Circulations (A. B. C.).

Repairs of locomotives are now being rushed. Frank McManamy, manager of the locomotive section of the Railroad Administration, says that on the government-controlled roads about 4,800 engines are passing through the shops each week, or 700 more than a year ago.

The salary of the chief inspector of locomotive boilers of the Interstate Commerce Commission is to be raised from $4,000 to $5,000 a year, the salaries of the two assistant inspectors from $3,000 to $4,000, and of the district inspectors from $1,800 to $3,000; all by virtue of a law passed by the Lower House of Congress, on June 5, and by the Senate, on June 18.

A senior inspector of motive power is wanted by the United States Civil Service Commission, for a position in the Division of Valuation, of the Interstate Commerce Commission, Eastern district; salary $1,800 a year. Applications will be received up to July 16. Applicants must be between 25 and 60 years old and the examination will cover the qualifications for all grades in this department up to a salary of $3,600 a year.

The United States Government is expected to place large orders shortly for additional cars and locomotives for service on the military railway lines in France. General Pershing has cabled to Washington requirements for locomotives, cars and steel which will greatly increase the orders already placed by S. M. Felton, director general of military railways, which include about 30,000 cars and 2,000 locomotives. The number of cars and engines is understood to be so large as to cause some perplexity on the part of the authorities in charge of the apportionment of the steel supply.

Scarcity of steel is now so very general that the amount which may be used for railroad purposes will be determined only after careful scrutiny. An agreement has been entered into with a committee of the American Iron & Steel Institute under which the board will pass upon all applications for steel products and pig iron. When a railroad requires steel, the need for it must be first approved by the regional director, and it must then be passed upon by J. Leonard Replogle, director of steel supply for the War Industries Board, who assigns the manufacture to one of the various plants. The steel required for the government cars and locomotives was allotted by Mr. Replogle through the American Iron & Steel Institute.

Railroad Men Thanked

Director General McAdoo has issued a circular expressing his appreciation of the patriotism of the railroad employees of the country who subscribed for Liberty Bonds and urging them to invest in War Savings Stamps. The circular says, in part:

"I am deeply gratified to learn of the large number of railroad employees who have subscribed for the third issue of Liberty Bonds. . . . A large number of railroad employees will receive substantial amounts of back pay. . . . I earnestly urge upon every railroad employee who has thus secured increases in pay to invest as much as he possibly can in the War Savings Stamps."

The Status of the Freight Car Orders

Although all of the specialties had not yet been ordered, the Director General's office at Washington announced on June 19 that the first of the 31,000 freight cars ordered from the American Car & Foundry Company had been completed. This is merely a sample car built for inspection purposes and does not necessarily conform to the final specifications so far as specialties are concerned.

The proposed order for 2,000, 40-ton box cars to the Barney & Smith Car Company, which was shown in the list of car orders published last month, was not placed. Instead, 1,000 of these cars were added to the order of the American Car & Foundry Company, 500 to that of the Keith Car & Manufacturing Company, and 500 were ordered from the McGuire-Cummings Manufacturing Company.

It is understood that orders for 50,000 additional cars, to include stock, refrigerator, general service and flat cars, are to be placed after the delivery of the first cars ordered is well along, from plans and specifications which have already been prepared by the car and locomotive standardization committee.

Headlight Order Effective July 1

The Interstate Commerce Commission's order of October 11, 1915, requiring locomotives to be equipped with high-power electric headlights, which has been three times extended, became effective on July 1. It applies to all new locomotives and all locomotives sent to the shop for general or heavy repairs after that date; and all locomotives must

be equipped by July 1, 1920. About 40,000 engines are now equipped with high-power lights, which leaves about 26,000 more to be equipped. The new standard locomotives recently contracted for by the Railroad Administration are to be equipped with lights ordered from the Pyle-National Electric Headlight Company, but on other locomotives the roads may use any light they desire, if it complies with the commission's order. This requires for road locomotives a light "which shall afford sufficient illumination to enable a person in the cab who possesses the usual visual capacity required of locomotive enginemen, to see in a clear atmosphere, a dark object as large as a man of average size standing erect at a distance of at least 800 feet ahead and in front of such headlight." For yard locomotives the distance is 300 feet.

Officers Required for Railway Troops

S. M. Felton, director general of military railways, has issued a new call for railway men for service on the American lines of communication overseas.

With the growth of our armies in France many additional officers for railroad troops that are now forming and which will be formed in the near future will be required. The director general military railways realizes the necessity of retaining American railroad officers in their present positions and that the operation of the American railroads must be maintained, but there is such necessity for officers for railway troops in France that he is calling for *experienced railroad men who are now employed in other active pursuits.* He has requested that railroad officers send to him the names of their acquaintances who would be possible candidates.

The following statement gives an outline of the qualifications required; the official rank for which commissions will be issued, with their several rates of pay; the commutation of quarters being allowed when officers are maintaining their families in this country:

Qualification	Rank	Rate of pay			Total	
		U. S.	Foreign	Commutation of quarters	U. S.	Foreign
Asst. general manager	Major	$3,000	$3,300	$720	$3,720	$4,020
General superintendents	Major	3,000	3,300	720	3,720	4,020
Superintendents—Motive power	Major	3,000	3,300	720	3,720	4,020
Division superintendents	Captain	2,400	2,640	576	2,976	3,216
Master mechanics	Captain	2,400	2,640	576	2,976	3,216
Engrs. maintenance of way	Captain	2,400	2,640	576	2,976	3,216
Trainmasters	1st Lt.	2,000	2,200	432	2,432	2,632
Div. engrs.—maintenance of way	1st Lt.	2,000	2,200	432	2,432	2,632
Chief despatchers	1st Lt.	2,000	2,200	432	2,432	2,632
Road foremen of engines	1st Lt.	2,000	2,200	432	2,432	2,632
General yardmasters	1st Lt.	2,000	2,200	432	2,432	2,632
Enginehouse and shop foremen	1st Lt.	2,000	2,200	432	2,432	2,632
Asst. division engineers	2nd Lt.	1,700	1,870	288	1,988	2,158
Yardmasters	2nd Lt.	1,700	1,870	288	1,988	2,158
Supervisors and roadmasters	2nd Lt.	1,700	1,870	288	1,988	2,158
Asst. enginehouse and shop foremen	2nd Lt.	1,700	1,870	288	1,988	2,158

In addition to the above there is a small allowance made for heat and light which varies according to the location of station and season of the year.

It is desired that as many men as possible communicate with the Director General Military Railways' office, Sixth and B streets, N. W., Washington, D. C., and that in these communications they give in detail their railroad experience and their references. The call for these men is pressing and it is hoped that there will be a hearty response.

U. S. Employment Service to Regulate Labor

The government is to control labor distribution as completely as possible. After August 1, industries employing more than 100 men will be required to employ common labor through the United States Employment Service. The Department of Labor aims at the elimination of private competition for workers, and all government departments and boards concerned with war production and having to do with the letting of contracts for war materials have agreed to its plans. Felix Frankfurter, assistant to Secretary of Labor, is chairman of the "War Policies Board" of the Department of Labor. All war industries will be requested to facilitate in the centralization program by stopping independent labor recruiting activities which have demoralized the labor market, caused a tremendous labor turnover and kept much available labor constantly jumping from one place to another.

President Wilson on June 17 issued a proclamation approving the plan and urging all employers engaged in war work to refrain from recruiting unskilled labor in any manner except through the central agency.

MEETINGS AND CONVENTIONS

The Traveling Engineers' Association.—The Railroad Administration has authorized the Traveling Engineers' Association to hold the next convention at Chicago, Ill., commencing September 10, 1918. The following are the subjects to be discussed:

(1) Fuel Economy under the following heads (a) Value of present draft appliances; can they be improved to effect fuel economy? (b) Best practice for handling locomotives at terminals to reduce coal consumption. (c) How can engnemen and firemen effect the greatest saving of fuel when locomotives are in their charge? (d) Whether it is most economical to buy cheap fuel, at a low heat value or a higher priced fuel at a greater heat value. (e) The most economical method of weighing fuel when delivered to locomotives, in order that individual records of coal used by enginemen and firemen may be kept. (f) Superheat applied to locomotives as effecting coal consumption.

(2) Engine Failures—causes and remedies, best methods of investigating same, and placing responsibility.

(3) The use of superheat steam in slide valve engines. Drifting, relief and by-pass valves or the absence of any one or all on superheat locomotives equipped with piston valves.

(4) Cab and cab fittings on modern locomotives, from the viewpoint of the engineman.

(5) How can the traveling engineer and general air brake inspector best co-operate to improve and maintain the air brake service?

There will be opportunity for such other matters as may be considered of interest to the association and the railroads under changed conditions.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—V. R. Hawthorne, Karpen Bldg., Chicago.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—R. D. Fletcher, Belt Railway, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 Lawlor Ave., Chicago. Second Monday in month, except June, July and August, Hotel Morrison, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—W. R. McMunn, New York Central, Albany, N. Y.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, C. H. & D., Lima, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 542 W. Jackson Blvd., Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1126 W. Broadway, Winona, Minn.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York.

MASTER CAR BUILDERS' ASSOCIATION.—V. R. Hawthorne, Karpen Bldg., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio. Next meeting, September 10, 1918, Chicago.

PERSONAL MENTION

FEDERAL ADMINISTRATION APPOINTMENTS

C. B. DAILEY, assistant to the director of purchases of the Southern Pacific, has been appointed assistant manager of the procurement section of the Central Advisory Purchasing Committee of the Railroad Administration.

G. M. DAVIDSON, chemist and engineer of tests of the Chicago & North Western, at Chicago, has been appointed a member of the inspection and test section of the United States Railroad Administration for the western region.

B. J. FEENEY, traveling engineer of the Yazoo & Mississippi Valley, has been appointed supervisor of the Fuel Conservation section of the United States Railroad Administration, for the Southern Regional district, with office at Atlanta, Ga. Mr. Feeney was for nine years employed as a machinist, locomotive fireman and engineman on the Chicago and Kentucky divisions of the Illinois Central, then for 10 years was a traveling engineer on the Kentucky division, and for six years was traveling engineer at the Memphis Terminal, in charge of fuel economy and smoke prevention. He was with the Yazoo & Mississippi Valley since 1916 as traveling engineer, his office being at Memphis.

H. L. INGERSOLL, assistant to the president of the New York Central, has been appointed mechanical assistant in the office of the eastern regional director in New York.

C. T. MARKEL, general foreman and chief locomotive inspector of the Chicago & North Western, and J. A. Rickabaugh, supervising inspector of the Pennsylvania, have been appointed, respectively, chief construction inspectors of locomotives and cars for the Inspection and Test Section of the Railroad Administration. They will have charge of the inspectors at the various plants throughout the country where the Administration has purchased equipment.

H. B. MACFARLAND, engineer of tests of the Atchison, Topeka & Santa Fe at Chicago, has been appointed a member of the inspection and test section of the United States Railroad Administration for the western railroad region. Mr. MacFarland has also been assigned to one of the 18 districts which have been created for the inspection and testing of materials which will be used in the construction of the car and locomotive equipment recently ordered by the government. His district will comprise southern Ohio and the territory tributary to St. Louis, Mo.

FRANK MCMANAMY has resigned as chief inspector of locomotive boilers of the Interstate Commerce Commission and has been appointed mechanical assistant to the director of the Division of Operation of the Railroad Administration, effective on July 1, succeeding H. T. Bentley, resigned. In this position he will have jurisdiction over the Car Repair and Inspection and Test Sections and general charge of matters pertaining to locomotive and car equipment. Mr. McManamy has also been manager of the locomotive section of the division of operation.

H. C. PEARCE, general purchasing agent of the Seaboard Air Line, has been placed in charge of the procurement section of the Central Advisory Purchasing Committee of the United States Railroad Administration, with headquarters at Washington, D. C. This section has been established for the purpose of facilitating the procurement and delivery of the material required in the production of the cars and locomotives ordered by the Railroad Administration.

L. G. PLANT has been appointed progress engineer of the procurement section of the Central Advisory Purchasing Committee of the United States Railroad Administration.

H. E. SMITH, engineer of tests of the New York Central, has been named as chief materials inspector of the Inspection and Test Section of the Railroad Administration. He will have charge of the inspection and testing of all the material purchased for use of the Railroad Administration.

H. C. WOODBRIDGE, assistant to general manager of the Buffalo, Rochester & Pittsburgh, has been appointed regional supervisor in the Fuel Conservation section of the Railroad Administration, with headquarters at Philadelphia, Pa.

F. ZELENY, engineer of tests of the Chicago, Burlington & Quincy, at Aurora, Ill., has been assigned to one of the 18 districts created by the inspection and test section of United States Railroad Administration, his district comprising Chicago and surrounding territory.

GENERAL

H. C. BENTLEY, superintendent of motive power of the Chicago & North Western, who has been serving at Washington as mechanical assistant in the Division of Operation of the Railroad Administration, has resigned and has returned to his office in Chicago. Mr. Bentley's resignation was due to ill-health. As chairman of the committee on standards, he has had active charge of preparing standards for government engines and freight cars.

H. C. MAY, superintendent of motive power of the Chicago, Indianapolis & Louisville, has been appointed general manager, with office at La Fayette, Ind.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

JOHN VASS, road foreman of engines of the Grand Trunk, at Battle Creek, Mich., has been appointed assistant master mechanic of the Ontario lines, with headquarters at Allandale, Ont., in place of J. R. Donnelley, retired.

PURCHASING AND STOREKEEPING

H. P. MCQUILKIN has been appointed assistant general storekeeper of the Baltimore & Ohio, with office at Baltimore, Md., succeeding E. W. Thornley, who has been furloughed to accept service in the office of the Allegheny Regional Purchasing Committee.

OBITUARY

C. J. STEWART, mechanical superintendent of the New York, New Haven & Hartford, with headquarters at New Haven, Conn., died recently at Twin Lakes, Conn., at the age of 51. Mr. Stewart began railway work with the Erie as a caller and subsequently served consecutively as engine despatcher, special apprentice, fireman, engine inspector and foreman on that road. He then entered the service of the Delaware, Lackawanna & Western as machinist, and later served as foreman and general foreman until 1905, when he went to the Central New England as master mechanic. In 1913 he was appointed assistant mechanical superintendent of the New York, New Haven & Hartford, at New Haven, Conn., and in 1917 was appointed mechanical superintendent.

C. J. Stewart

Supply Trade Notes

The United States Metallic Packing Company, Philadelphia, Pa., has moved its offices in that city to 221 North Thirteenth street.

The Sprague Electric Works of the General Electric Company announces the removal of its Boston office from 201 Devonshire street to 84 State street.

The H. W. Johns-Manville Company announces that after July 1, 1918, its Houston office will be located at 424-426 Washington avenue, Houston, Texas.

W. M. Bosworth has resigned as mechanical engineer of the Norfolk Southern to go into the engineering department of the Underfeed Stoker Company, Chicago.

The Burden Sales Company, Inc., New York, announces the removal of its office from 30 Church street to the Forty-second street building, 30 East Forty-second street.

Stanley W. Midgley, general sales manager of the Acme Supply Company, Chicago, has been appointed western representative in charge of railroad sales of the Liberty Steel Products Company, at Chicago. He was born at Chicago in 1875. After completing his education at the Lewis Institute (Chicago) he entered the sales department of the Great Western Cereal Company, having charge of the wholesale trade, with headquarters at Chicago. From 1902 to 1906, Mr. Midgley was general sales representative of the National Car Coupler Company, at Chicago, and from 1906 to 1914 he was western representative and western sales manager of the Curtain Supply Company, in the same city. Subsequently, he became general sales manager of the Acme Supply Company, with headquarters in Chicago, and remained with that company until his recent appointment as mentioned above.

S. W. Midgley

Charles P. Wright, sales representative of the American Brake Shoe & Foundry Company, at Chicago, has been appointed assistant to the vice-president, with headquarters at Chicago.

The Smith & Hemenway Company, of New York, has found it necessary to increase its output to meet the demands for "Red Devil" tools, and has erected a new building at Irvington, N. J., which is now being completed.

The directors of the Pullman Company on June 10 elected John F. Kane secretary, succeeding A. S. Weinsheimer, deceased, and Charles S. Sweet, formerly chief clerk in the president's office, was elected assistant secretary, succeeding Mr. Kane.

The new accessory plant of the American Locomotive Company at Richmond, Va., where piston valves, flexible staybolts, reverse gears and the other accessories are to be manufactured has been placed under the charge of Ross Anderson as manager.

The Parkesburg Iron Company announces the following changes among its resident sales managers, effective June 1, 1918: R. J. Sheridan, New York, and G. W. Denyven, Boston; after July 1, 1918, J. A. Kinkead, San Francisco. The other selling representatives remain the same as at present.

Joseph W. Weinland, sales manager of the brake beam department in the Chicago office of the American Steel Foundries, has been appointed district manager of the Liberty Steel Products Company, with headquarters at Chicago. Mr. Weinland was born at Chatsworth, Ill., on December 13, 1877. In 1902, he entered the service of the Western Steel Car & Foundry Company, as assistant purchasing agent. A considerable part of his time was spent on the Pacific coast, purchasing lumber to be used in the building of cars. Later he was promoted to purchasing agent of the Anniston, Ala., shop. For a period of five years following 1907, he was engaged in the construction and sale of 50 houses at Burnham, Ill. In 1912 he re-entered the railway supply field with the American Steel Foundries as sales manager in the brake beam department, which position he held until his recent appointment, as mentioned above.

J. W. Weinland

Charles A. McCune, for 12 years connected with the Commercial Acetylene Company of 80 Broadway, New York, has resigned to accept the position of sales engineer with the Page Steel & Wire Company, 30 Church street, New York. Mr. McCune was born in Jersey City, N. J., in 1879, and before entering the acetylene field was for several years connected with the Safety Car Heating & Lighting Company. He left in 1906 to take up the duties of assistant engineer with the Commercial Acetylene Company and since then has been actively engaged in this industry, his work in the greater part being devoted to the development and application of dissolved or compressed acetylene. In 1908, he perfected the first successful inverted acetylene burner and mantle for railroad car lighting purposes; this system being partly used on the Delaware, Lackawanna & Western until a few years ago, when the road practically went over to electric lighting. In 1916, Mr. McCune became chief engineer of the Commercial Acetylene Company. Mr. McCune will be succeeded by David Ahldrin, who was formerly connected with the A. G. A. Company and also the Commercial Acetylene Company.

C. A. McCune

The Q & C Company, of New York and Chicago, announces the appointment of the General Supply Company, Ltd., of Canada (358-360 Sparks street, Ottawa, Canada, with branch offices at Montreal, Winnipeg and Vancouver), as sole representatives in Canada.

Lloyd H. Atkinson has resigned his position as president of Atkinson & Utech, Inc., to become vice-president of the Air Reduction Company. He will, however, continue to serve on the board of directors of Atkinson & Utech, Inc. John J. Utech has been elected president to succeed Mr. Atkinson, and I. W. Glasel has become secretary and treasurer of the same company.

Frank W. Edmunds has been appointed general eastern sales manager of the Schroeder Headlight & Generator Company, of Evansville, Ind., with offices at 30 Church street, New York. Mr. Edmunds, like many of the prominent men allied with the railway supply industry, began his business career as an office boy. His first employer was the man who put up the money for and built the famous "Monitor" of Civil War days, John A. Griswold, president of John A. Griswold & Co. With this company Mr. Edmunds stayed until it became the Troy Steel Company and then some years later liquidated. In the meantime he had been made secretary, treasurer and general sales manager. He then became secretary of the Q & C Company at Chicago, acting also as western representative of the Pennsylvania Steel Company. He resigned from this position to become associated with the Dressel Railway Lamp Works, of New York, with which company he has been for 15 consecutive years, resigning as sales manager to accept the position mentioned above. The change became effective June 15. Mr. Edmunds served for years on various committees of the Railway Supply Manufacturers' Association and other associations, and is now the secretary-treasurer of the Signal Appliance Association.

F. W. Edmunds

A. B. Cole has been appointed assistant to manager of the Department of Publicity, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., to succeed M. C. Turpin, who has accepted a position in the Ordnance Department at Washington, D. C. Mr. Cole will have charge of the editorial work, including the preparation of literature, and supplying information to the press.

E. C. Peck, superintendent of the Cleveland Twist Drill Company at Cleveland, Ohio, has received an appointment as lieutenant-colonel in the engineering bureau of the ordnance department. Mr. Peck will have charge of the gages used in the production of munitions and kindred materials for the above department. His duties will be the supervision of design of gages and the settling of limits of variance which will be satisfactory to both manufacturer and the ordnance department itself.

The degree of Doctor of Engineering was conferred upon Walter V. Turner, manager of engineering for the Westinghouse Air Brake Company, by the University of Pittsburgh at the annual commencement, in recognition of his services to the engineering profession and to humanity. Mr. Turner is considered the foremost pneumatic engineer in the world, and has over four hundred (400) inventions, covered by U. S. patents, in use on most railways of the world and in many large industrial plants.

The officers of the Chicago Malleable Casting Company, the Universal Draft Gear Attachment Company, and the Union Draft Gear Company, of Chicago, have formed a new corporation called the Allied Steel Casting Company of Chicago, and have purchased the Harvey, Ill., plant of the Whiting Foundry Equipment Company. The officers and organizations of the Chicago Malleable Casting Company, the Universal Draft Gear Attachment Company, and the Union Draft Gear Company are not changed, and the companies continue business as before.

A. S. Weinsheimer, secretary of the Pullman Company at Chicago, died on May 11, at the age of 72 years. Mr. Weinsheimer was born at Allentown, Pa., on May 12, 1846, and entered railway service in 1860 with the Lehigh Valley with which he was consecutively telegraph operator, freight clerk and ticket agent. From 1864 until the termination of the Civil War he was connected with the U. S. Army Quartermaster's department at various points on the Baltimore & Ohio. In 1865 he again entered the service of the Lehigh Valley in the coal department. He severed his connections with that company in 1871 to go with the Pullman Palace Car Company, at Chicago, and served it and its successor, the Pullman Company, until his death. He was cashier from September 1, 1875, to September 13, 1878, and from the latter date until his demise was secretary.

D. F. Crawford, who recently resigned as general manager of the Pennsylvania Lines West of Pittsburgh, has been elected vice-president of the Locomotive Stoker Company, with headquarters at Pittsburgh, Pa. When in railway service, Mr. Crawford obtained extensive experience in both mechanical and executive positions. He was born at Pittsburgh, December 4, 1864, and attended the city and private schools and also the Pennsylvania Military College. He entered the service of the Pennsylvania System in July, 1882, in the freight department, transferring to the Altoona shops in December, 1885, as a special apprentice. From 1889 to February 1, 1892, he was an inspector in the test department. In February, 1892, he was appointed assistant master mechanic of the Fort Wayne shops of the Pennsylvania Lines West of Pittsburgh. From July 1, 1895, to November 1, 1899, he was assistant to superintendent of motive power of the Northwest System of the Pennsylvania Lines West and on the latter date was made superintendent motive power of the same system, where he remained until August 1, 1903, when he was appointed general superintendent of motive power of the Pennsylvania Lines West of Pittsburgh. On January 1, 1917, he was promoted to general manager of the Lines West. Mr. Crawford was president of the Master Mechanics' Association in 1913, and in 1915 he was president of the Master Car Builders' Association. Since 1903, he has devoted much time and attention to the use and development of mechanical stokers

D. F. Crawford

for locomotives—and during this period developed the Crawford underfeed stoker, which is in extensive use on the Pennsylvania Lines West.

W. S. Murrian, superintendent of motive power and equipment of the Southern Railway, resigned on May 1, to become president and general manager of the Southern Locomotive Valve Gear Company, Knoxville, Tenn. Mr. Murrian learned the trade of machinist and worked in that capacity for several years. He came from the Union Pacific 15 years ago to the position of master mechanic of the Southern Railway at Alexandria, and was later transferred to Spencer, N. C., in the same capacity. At that time the Southern Railway was building the largest locomotive shops on the system at Spencer. After about two years' service at that point, Mr. Murrian was promoted, in 1906, to superintendent of motive power, with headquarters at Knoxville, Tenn. Mr. Murrian is personally interested in the specialties now being manufactured by the Southern Locomotive Valve Gear Company, and he is also thoroughly familiar with the efficiency of the commodities, the Southern Railway having adopted the Southern valve gear as its standard several years ago. Mr. Murrian succeeded General L. D. Tyson, now in active service in the United States Army, who had been president since the organization of the company.

The election of Stephen C. Mason, secretary of the McConway & Torley Company of Pittsburgh, as president of the National Association of Manufacturers, announced in last month's issue, is of more than ordinary interest to the railway and railway supply field, because Mr. Mason's entire business career has been confined to some branch of railroad work. He began on November 10, 1880, as a station agent in his home town, Lyndonville, Vt. As soon as he took up the work he learned telegraph operating, and before he was 20 years old was called to the headquarters of the Connecticut & Passumpsic Railroad, and made local freight agent at the headquarters of the division. After a few months' service there he was taken into the superintendent's office and made his private secretary. After the creation of the Interstate Commerce Commission, Mr. Mason applied for and secured a position with that body in Washington first in the office of the auditor of the commission, where he had charge of the tariffs filed by the railroad companies. Upon the creation of the division of statistics, of which Professor Henry C. Adams was the head, Mr. Mason was placed in that department, and remained there until 1896, when he occupied the position of assistant statistician. At that time he was offered a position with the McConway & Torley Company of Pittsburgh, which he accepted in January, 1896, and in whose service he has been continuously ever since. He has served in various capacities. His first experience was gained as a traveling representative, after which he acted as assistant to the superintendent of the plant, thus gaining a practical experience in the manufacturing operations. Later he was designated assistant to the president, an office which he held until the death of Charles B. Krauth, when he was elected secretary and later a member of the board of directors.

S. C. Mason

CATALOGUES

BRAKE BEAMS.—The American Steel Foundries, 30 Church street, New York, has recently issued a 34-page catalogue describing the Ajax and Hercules brake beams, the Simplex clasp brake, and the Atlas safety guards.

WOOD MILLER.—In a well-illustrated, four-page folder, the Oliver Machinery Company, Grand Rapids, Mich., describes its No. 75 wood milling machine. Its application to all kinds of pattern work, including gear patterns, is plainly shown in the folder.

SUPERHEATER DAMPERS.—The Locomotive Superheater Company, 30 Church street, New York, has recently issued Bulletin No. 3 on superheater dampers. The proper methods of installing, operating and maintaining the dampers are plainly illustrated and described.

WROUGHT IRON PIPE.—A photomicrograph showing a section of pipe magnified 60 diameters is an interesting feature of a folder recently issued by the A. M. Byers Company, Pittsburgh, Pa. The reason for the rust resisting properties of wrought iron is clearly brought out, and records of installation of Byers pipes are cited in the folder.

PORTABLE ELEVATOR.—The New York Revolving Portable Elevator Company, Jersey City, N. J., has issued recently Bulletin No. 50, entitled The Revolvator, describing their portable elevator or tiering machine which is used in storerooms and warehouses for the piling or stacking of goods. The bulletin is well illustrated and shows in considerable detail how the Revolvator can be used for many different kinds of work.

RIVET CUTTER.—The Rice Manufacturing Company, Indianapolis, Ind., has just issued an attractive booklet describing the "Red Devil" rivet cutter. This booklet contains detailed and complete information regarding the rivet cutter manufactured by this company, and several illustrations show its actual operation in railroad shops. In the back of the booklet there are several tables of value for reference purposes to men working on steel cars.

MOTIVE POWER PROBLEM.—The Baldwin Locomotive Works in Record No. 90 has issued in booklet form the address of its president, Alba B. Johnson, before the annual convention of the Chamber of Commerce of the United States, at Chicago, April 11, entitled "The Problem of Motive Power Under the National Administration of Railroads." An abstract of Mr. Johnson's paper was published in the *Railway Mechanical Engineer* for May, on page 246.

THE LOCOMOTIVE FURNACE.—Bulletin No. 1 of the American Arch Company is a condensed treatise on combustion and the relation of locomotive furnace and boiler proportions to the efficiency of combustion and heat absorption in the locomotive boiler, prepared by J. T. Anthony. The text is illustrated with charts, diagrams and drawings and is based upon a thorough study of the available data bearing upon the subject. It should be in the hands of every locomotive designer.

INDUSTRIAL LIGHTING.—Scientific Industrial Illumination is the title of a 36-page, illustrated booklet recently issued by the Holophane Glass Company, 340 Madison avenue, New York City. The booklet is divided into four parts showing the need for correct lighting, the fundamental principles involved, and the various types of industrial lighting units manufactured by the Holophane Company. The fourth section of the catalogue contains several reference tables and general engineering data.